American Anthropologist

NEW SERIES

VOL. 5 — OCTOBER–DECEMBER, 1903 — NO. 4

A STUDY OF THE BRAIN OF THE LATE MAJOR J. W. POWELL

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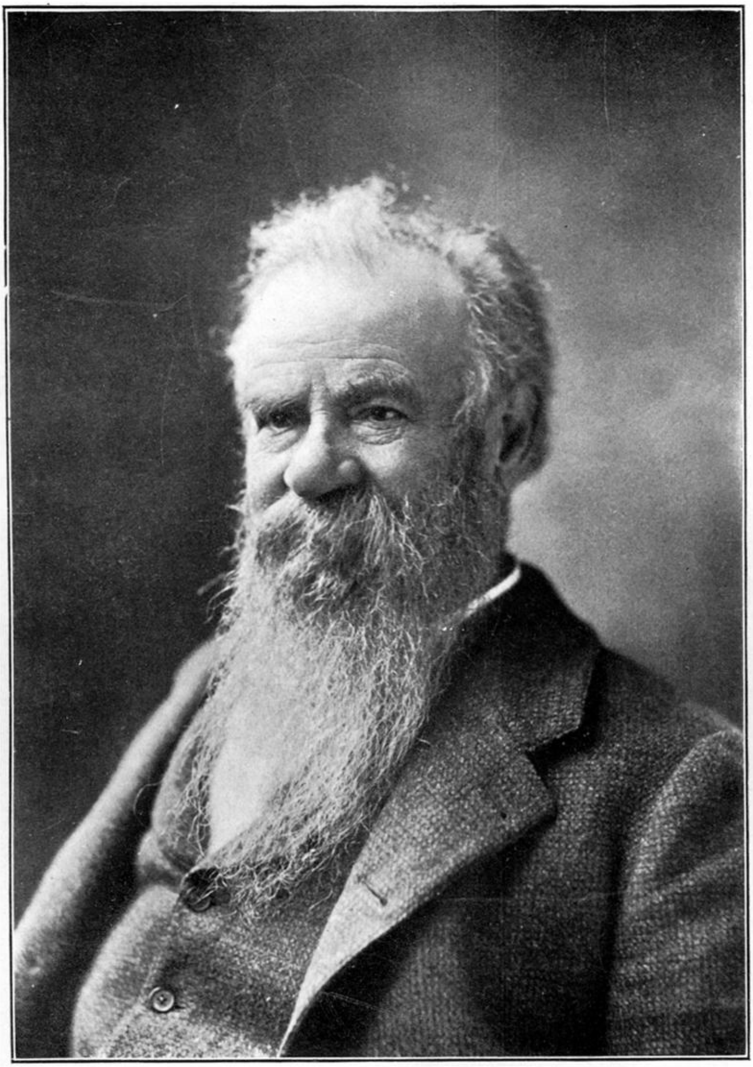
INTRODUCTION

The fortunate preservation of the brain of Major J. W. Powell affords another opportunity for placing on record the cerebral characteristics of a distinguished man. Major Powell will ever be remembered for the vigorous brainy qualities by means of which he exerted a great influence upon his fellow-workers and greatly favored the progress of those branches of science to which he was most devoted. His personality was one which will remain cherished in the memory of all who knew him; the forceful workings of his brain earned him the leading position in the ranks of science-makers, and his clear foresight, his courage, energy, sympathy, and independence of character have met with universal admiration.

Through the kindness of Dr W J McGee, Dr Frank Baker, and Dr D. S. Lamb, the writer was permitted to undertake the study of this brain with the view, first, of placing a morphological description of it on record, and further with the view of correlating, if possible, certain of Major Powell's pronounced mental characteristics with the anatomical appearances of the brain. The results of this study were given, in part, before the Anthropological Society of Washington.[1] In presenting a completed account of the researches upon this brain, the writer proposes to review (*a*) briefly the objects and

[1] "Cerebral Characteristics of Distinguished Men, with Special Reference to the Late Major J. W. Powell," read May 12, 1903.



JOHN WESLEY POWELL

the history of similar examinations of the brains of notable persons, (*b*) the weight of such brains and certain features of the cerebral surface morphology as compared with those of persons of ordinary intellectual powers, (*c*) a morphological description of Major Powell's brain, and (*d*) a discussion of the possible relations which certain features noted in the brain may bear to some of Major Powell's chief mental characteristics.

I

That the brains of men intellectually eminent should come to the hands of anatomists for the purposes of correlating, if possible, the encephalic weight, form, and fissural pattern with the bodily and mental powers is but a sign of scientific progress, and the subject should form no unimportant branch of anthropometrical research. When we remember that in the human species the brain has attained the highest degree of perfection, and experience teaches that the manifestations of brain-action differ considerably in the races and social classes; when we remember that all that has ever been said or written, carved or painted, discovered or invented, has been the aggregate product of multifarious brain-activity, it seems but reasonable to seek for the somatic bases for these powers and their differences in different individuals. Men are as variously endowed with intellectual powers as they are with any other traits. It is our business to endeavor to ascertain why and how some are more, some less, gifted than others; it is not enough merely to admire the genius of an Archimedes or a Homer, a Michelangelo or a Newton; we wish to know how such "men of brains" were capable of these great efforts of the intellect, and what gave them the capacity for doing things, as it were, "without taking pains." "Millions," says Hartmann, "stare at a phenomenon before a *genialer Kopf* pounces on the concept." In a general way, comparative physio-psychology has aided us in the search for the key to this great problem. We know the mind of man to differ most from that of the brute in the unusual development of the associations of recepts and concepts, *i. e.*, the powers of reasoning. But if in the brain of the average man there be a hundred or two hundred or five hundred connections for every fact that he remembers, their number is many times greater in that of the intellectually superior

genius. An elaboration of brain-structure must therefore accompany the higher intelligence, and it is in this direction that our researches must be pursued.

The question as to what means shall be employed brings forth a very great number of difficulties. The structure of the brain is the most complex of all the bodily organs; its anatomical make-up is only beginning to be understood; and though the science of brain architecture and action can be said to be only in its infancy, the great array of even the most recently accumulated facts alone can stagger any one. As a subject of study, the brain occupies the most unique position of all the viscera; investigators must truly "cudgel their own brains" in studying the brains of others, and Greek meets Greek in a veritable tug-of-war. The proposition, then, of attempting to correlate a manifest elaboration of the mental powers with (what we may for the present assume to be) an elaboration of cerebral structure, cannot, in the state of our knowledge at this time, be discussed as a whole, but rather in the form of numerous subdivisions which may in the future be blended in a more comprehensive manner.

Some of the problems which have been receiving the most attention until now are based upon the microscopical study of the unit of the nervous system, the neuron or nerve-cell and axis-cylinder (axone) with the numberless dendrites, and upon the intricate grouping and chaining of these millions of neurons within the central nervous system. Not less important are the studies of the morphological appearances of the cortical surface, the comparative extent of certain cortical areas, upon the weight of the brain and its component parts, as well as in comparison with that of the spinal cord; of the ratio between the collective cross-section area of the cranial nerves and of the spinal cord; of the number of fibers in different tracts, be they efferent, afferent, or associative;[1] on the relative bulk of gray and white matter; on the progressive myelinization of different nerve-fiber tracts, and so on almost without end. Such studies are of great value in elucidating many of the problems of

[1] A comparative study of the form, dimensions, and number of fibers in the callosum of different animals and of different human individuals would prove most interesting and instructive.

cerebral localization of functions; problems of great importance in the clinical diagnosis of brain-injury, disease, or defect. In their relations to phylogeny, to psychology, education, and the study of the evolution of man in general, they are unquestionably of high value.

It is to Rudolph Wagner,[1] of Göttingen, that we are indebted for having made the beginning in this kind of study. He was so fortunate as to obtain the brains of the physicist and mathematical genius Friedrich Gauss, the pathologist Carl Fuchs, the French mathematician Dirichlet, the philologist Carl Hermann, and the mineralogist Hausmann. In Wagner's time the study of cerebral surface morphology was yet in its infancy. Wagner was therefore not in a position to treat of these brains in a detailed manner, and he could discuss them only in the way of a general comparison. With so little material at hand, Wagner was rather premature in expressing himself satisfied that complexity and richness of convolution were not in relation with greater intellectual capacity. The brain of Gauss — mathematician and astronomer, productively active in the field of dynamic physics, precocious in youth, vigorous in old age — has stood unique as showing the most complex configuration and intricate fissuration, for over forty years — and this amongst thousands upon thousands of brains more or less carefully examined by investigators fully alive to the importance of the subject.

Subsequent to the publication of Wagner's work, similar investigations were taken up in Paris and Munich, and, on this side of the Atlantic, in Ithaca, Philadelphia, and New York. Interest in the subject has been revived in other centers of scientific progress, notably in Stockholm, where Professor Retzius has already published the descriptions of the brains of three distinguished persons.

A brief review of what has been done with the brains of notable individuals may prove interesting. Aside from vague, perhaps even mythical, references to the brains of La Place, Rousseau, von Siebold, Byron, Beethoven, Pascal, Eduard Lasker, and Bismarck, we have complete studies of the brains of five members of the Parisian

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1 Wagner, *Vorstudien*, Göttingen, 1860–62.

Société Mutuelle d'Autopsie: Assezat,[1] Bertillon,[2] Coudereau,[3] Eugen Veron,[4] and Asseline,[5] and also that of Gambetta.[6] Retzius has described those of the astronomer Hugo Gylden,[7] the mathematician Mme Sonya Kovalewski,[8] and the physicist and pedagogue Per Adam Siljeström.[9] Others that have been described in detail are those of the composer-musician Rudolf Lenz,[10] General Skobeleff,[11] the anatomist Giacomini,[12] and the historian George Grote.[13] The writer has been so fortunate as to contribute descriptions of the brains of the two distinguished physicians Seguin, father and son,[14] the first instance on record where it was possible to compare the brains of blood relatives.[15] Partial studies have been made on the brains of Chauncey Wright (philosophical writer)[16] and Edward Oliver[17] (mathematician) by Professor Wilder, of Ithaca; that of Desider Szilagyi (the "Bismarck of Hungary"),[18] Professor Laborde,[19] De Morgan (mathematician),[20] Helmholtz (physicist and physiologist),[21] and the five brains mentioned above in Wagner's series. In Munich, Bischoff and Rudinger [22] have made special studies of cer-

[1] Duval et al. in *Bull. Soc. d'Anthropol.*, 1883.

[2] Chudzinski and Manouvrier, ibid., 1887.

[3] Laborde, Duval, et al., ibid., 1883.

[4] Manouvrier, ibid., 1892.

[5] Duval, et al., ibid., 1880 and 1883.

[6] Duval, ibid., 1886.

[7] Retzius, *Biol. Untersuch.*, 1898–1903.

[8] Ibid.

[9] Ibid.

[10] Guszman, *Anat. Anz.*, XIX, 1901, p. 239.

[11] Neiding in *Bull. Soc. d'Anthropol.*, 1882.

[12] Sperino in *Gior. d. R. Accad. di Med. di Torino*, 1900.

[13] Marshall in *J. Anat. and Physiol.*, XXVII, 1892, p. 30.

[14] Spitzka, E. A., in *Phila. Med. Jour.*, April 6, 1901.

[15] Exclusive of the Seguin brains and that of Major Powell, the writer has since had placed at his disposal the brains of eight other notable men of science, scholars, or public men, among them that of the late Major J. B. Pond. The results of the investigations upon these specimens will probably be published within the year.

[16] B. G. Wilder in *J. Nerv. and Ment. Dis.*, 1896, p. 706.

[17] Ibid.

[18] Sugar, *Orvosi Hetilap*, 1902, p. 8.

[19] Papillault in *Mém. Soc. d'Anthropol.*, 1903.

[20] Bastian, *Brain as an Organ of Mind*, 1880, p. 392.

[21] Hansemann in *Ztschr. f. Psych. u. Physiol. d. Sinnesorgane*, 1899, I.

[22] Rüdinger, *Anat. d. Sprachcentrums*, 1882, and *Beitrag z. Anatomie d. Affenspalte*, 1882.

tain regions of the cerebral surface (namely, the speech-center and the "intraparietal" fissure, together with the parietal regions in general) of the brains of eighteen intellectually eminent persons, as follows:[1] Justus von Liebig, chemist; Tiedemann and Doellinger, anatomists; G. H. E. Bischoff and Pfeufer, physicians; Harther, v. Poezl, and Wülfert, jurists; Melchior Meyr, H. v. Schmidt, Lichtenstein, and Schleich, litterateurs; Buhl, pathologist; Huber, philosopher; Hermann, economist; Harless, physiologist; Fallmerayer, historian; L. Meyer, surgeon, and Lasaulx, philologist. Reference has been made to a number of others, but in most cases the weight of the brain only was recorded and published.

The writer will, in this necessarily brief summary of what has been published concerning the brains of eminent men, confine himself to a consideration of the brain-weight and of the surface morphology of the cerebrum — both generally and with special reference to certain cortical areas. A discussion of the microscopical appearances or of any of the other kinds of cerebral investigation hinted at above must be omitted, since little or nothing has been done in these fields as yet. To be sure, Wagner sought to ascertain the possible relations of the area of the cortex to the degree of the intelligence, and while his results were quite significant, they were based on too few observations, and nothing further has since been accomplished in this direction.

II

The brain-weight of intellectual persons is a subject concerning which there has been much discussion. That the very slow accumulation of brain-weights of distinguished men, or of successful members of the liberal professions, has contributed to the existing diversities of opinion concerning the significance of the weight of the brain in its relations to the intelligence is clear to any one familiar with recent essays on the subject. Particularly disconcerting to some writers has been the not infrequent occurrence of unusually

[1] In this connection it is interesting to note that the skulls of Hamerling (described by Holl in *Arch. f. Anthropologie*, July, 1903), Bach, Kant, and other great men showed pronounced development of the parietal region, a feature actually determinable in the brains of Rudinger's series, and, as will be seen in the sequel, in Powell's brain as well.

heavy brains in idiotic persons, while certain low brain-weights of men ranking high in intelligence have prompted not a few anatomists and anthropologists — not content to defer judgment until a sufficient number of data had been collected — to make the flat assertion that "the weight of the brain is absolutely unrelated to the psychic faculties." It were indeed strange if we had thus to overthrow the general principles governing the functions of the brain as an apparatus of thought. Aside from the well-established proofs of the interdependence of brain-weight and intelligence in the animal series, there exist the very convincing studies of Ranke, Virchow, Manouvrier, and many others, pointing in no uncertain way to a decided relation between the cranial capacities of men and their psychic abilities. If, as Broca[1] has shown, the skulls of modern Parisians are larger than those of the twelfth century, that the cranial capacity of townspeople is as a rule greater than that of the peasants of the environs (Ranke[2]), and that the heads of university students have been found to be on the "average greatest and growing for the longest time in the group of most successful men" (Venn[3]), it would certainly seem that the size of the brain assumes, relatively speaking, that significance due this organ quite as much as, for example, the large size of the vestibular nerve in the *Cetacea* and *Phocidæ* relates to their remarkably skilful equilibristic movements.

A great number of unusually heavy brains found among idiots, imbeciles, criminals, insane, and other defectives, as well as a number among obscure bricklayers, blacksmiths, and common laborers, are fondly thrust before us to be taken in a manner as a refutation of the (to quote their usual phrase) "unfounded doctrine that the intelligence depends upon the size of the brain." Such cases are nearly always explained by pathological hypertrophy, either congenitally acquired or later developed during disease, and in the case of idiots and imbeciles, invariably characterized by grave defects in structure, such as abnormal increase of the neuroglia with profound diminution of ganglion cells, or abnormal gyral development, and so on. Idiocy may coexist, for instance, with apparent increase of

[1] Broca, *Mémoires*.

[2] Ranke, *Beitrag. z. Biol.*, 1882.

[3] Venn in *Nature*, 1890.

cortical substance and of the ganglion cells, but then the connecting fiber-systems are either retarded in their development or are entirely absent. Such disproportions and distortions render a normal cerebral mechanism out of the question. It were as unfair to include such unhealthy brains in a comparative study of brain-weights in their relation to the mental functions as it would be to assert the large liver in a case of hypertrophic cirrhosis to be better able to perform its functions than the smaller but healthy one. A pathological hypertrophy impairs the functional powers of any organ, but such is not the nature of the increase noted in the brains of certain men distinguished for mental ability. Those great water-logged, pulpy masses in the balloon-like heads of hydrocephalic idiots did not discover and never could have discovered the laws of gravity, invent the ophthalmoscope, create "Hamlet," or found modern natural history. The brains with which we here concern ourselves are those of men with healthy minds, who, in their life-time, attained high distinction in some branch of the professions, arts, or sciences, or who have been noted for their energetic and successful participation in human affairs.

Before we proceed to this analysis it must be emphasized that the weight of the brain is not the all-important factor which still another class of writers avers it to be. Aside from the fact that a certain volume and weight of the brain is absolutely essential to mental integrity, the external appearances — the architecture, so to speak,— often give, as will be shown later, the best indication of an individual's psychic abilities.

In a former contribution[1] the writer has treated the subject more fully than is possible in the present article, but it may not be amiss to reproduce here the series of actual brain-weights collected from all accessible sources (Table I). So far over 120 brain-weights have been collected, of which 103 could be selected, omitting those of noted persons who died insane or whose brains were not weighed in the fresh state. Gambetta's oft-quoted brain-weight is an instance of this kind, for the low figure is due chiefly to the fact that

[1] Spitzka, E. A., "A Study of the Brain-weights of Men Notable in the Professions, Arts and Sciences," *Phila. Med. Jour.*, May 2, 1903.

the body had been treated by an arterial injection of zinc chloride. Other brain-weights, cited elsewhere, are not included here until the figures can be verified from the original sources.

On the other hand, the writer is not at all persuaded to exclude, as has been urged, the brain-weights of Turgeneff and Cuvier. That of the former is an extraordinary figure (2012 gms.), but it is quoted from a very reliable source[1] and was accepted by contemporary authorities, notably such careful men as Topinard and Manouvrier. The physicians who performed the autopsy are certainly above the suspicion of carelessness or dishonesty of purpose. The Russian poet was a tall man, but not unusually so; his head was large, and the report that there was noted a tendency to symmetry of the cerebral convolutions may have some significance in this connection. As for Cuvier's brain, his alleged hydrocephalus, if it existed at all, did not in any way impair the magnificent mental powers of this founder of and most productive worker in the modern natural history. His death occurred at the age of 63, with mind unclouded. Cuvier's skull was large, macrocephalic; but who can say from its inspection that it was not simply and normally kephalonoid, or whether it was enlarged by undue accumulation of fluid? The alleged hydrocephalus of Helmholtz[2] seems to be based entirely upon the history of slight attacks of vertigo, of very rare occurrence — attacks which he might have had from a multitude of causes other than hydrocephalus, of which, by the way, no physical signs were observable in the shape of his head. Hansemann's vague references to a "slight dilatation of the ventricles" are best explainable by the two apoplectic hemorrhages which terminated Helmholtz's life six weeks later — a mode of death which materially lowered the true brain-weight. If the suggested theory of Perls and Edinger is to have for its foundation cases like these, the arguments in favor of the "advantages of a moderate hydrocephalus" (that is, if followed by a recession) as a means of increasing the brain and the intellectual powers, are of a very problematical nature indeed.

The actual weight of the brains of each of the persons men-

[1] *Procès verbal de l'Autopsie de M. Yvan Tourgueneff*, Brouardel, Descoust, Segond, et Magnin, Paris, Sept., 1883, p. 23.

[2] Hansemann in *Ztschr. f. Psych. u. Physiol. d. Sinnesorgane*, 1899, I.

tioned in the table has doubtlessly been influenced by the conditions and causes of death. These variations must, however, be disregarded here, except to mention that, as a general rule, the figures are rather lower than they should be by reason of atrophy from old age or from wasting diseases. In a few cases there is ample proof of this diminution in weight, as for example that of the anatomist and phrenologist Gall, who died at the age of 70, after a most active career, and whose brain had shrunken considerably, weighing only 1198 gms. The report of the autopsy mentions this atrophy as well as the existence of "four or five ounces of fluid" in the subdural space. The skull of Gall had an internal capacity of 1692 cubic centimeters, from which we may fairly infer that the brain must at one time have weighed fully 1475 gms. or more. Bischoff, for a like reason, would raise Tiedemann's 1254 to 1422, and Justus v. Liebig's 1352 to 1450 at least. At the autopsy on v. Liebig considerable fluid was found under the arachnoid, and that "the brain had already lost much of its nutrition during the last few days of life" may be deduced from the fact that it lost in weight very rapidly after immersion in alcohol, namely, 34 percent in the first month. Daniel Webster, with a cranial capacity of 1995 cc., probably had a brain weighing in his prime about 1735 gms., whereas after death it weighed over 200 gms. less. Spurzheim, with a skull capacity of 1950 cc., which would indicate a brain-weight of about 1695 gms., had an actual weight of only 1559 gms. The brain of v. Pettenkofer, who died at the age of 82, showed, Dr Bollinger informs me, a mild degree of atrophy. As I shall describe more fully in the sequel, the brain of Major Powell shows distinct signs of age-atrophy, and those of Whewell, C. Bischoff, Fallmerayer, and others are similar examples.

Aside from these atrophic changes there occur the inevitable errors due to variations in the amount of fluid and blood contained in the cavities and in the brain-substance itself, and in the thickness of the pia-arachnoid. These recur so frequently in brain-weighings that in the absence of special data they may be neglected since the relativity of the weights is not much impaired. So far as I know, all of the brains here tabulated were weighed with the pia-arachnoid; as those of the series weighed by Bischoff, Marchand, Topinard, and

Retzius, used here for comparison, were weighed under like conditions, further allowance need not be made.

Other factors known to affect brain-weight, such as stature,

TABLE I

NAME	OCCUPATION	AGE	BRAIN-WEIGHT
Ivan Turgeneff	Poet and novelist	65	2012
G. Cuvier	Naturalist	63	1830
E. H. Knight	Physicist and mechanician	59	1814
(Theologian ; Professor in Frei	burg University) ?	42	1800
John Abercrombie	Physician	64	1786
Benj. F. Butler	General and lawyer	74	1758
Edward Olney	Mathematician	59	1701
Herman Levi	Composer	60	1690
W. M. Thackeray	Humorist	52	1658
Rudolf Lenz	Composer	—	1636
John Goodsir	Anatomist	53	1629
Hosea Curtice	Mathematician	68	1612
C. G. Atherton	U. S. Senator	49	1602
W. v. Siemens	Physicist	68	1600
George Brown	Editor	61	1596
A. Konstantinoff	Litterateur	25	1595
R. A. Harrison	Chief Justice, Canada	45	1590
F. B. W. v. Hermann	Economist and statistician	73	1590
J. K. Riebeck	Philologist	61	1580
Hans Büchner	Hygienist	51	1560
K. Spurzheim	Anatomist and phrenologist	56	1559
Lavollay	Publicist	—	1550
Edward D. Cope	Paleontologist	57	1545
G. McKnight	Physician and poet.	57	1545
Harrison Allen	Anatomist	56	1531
J. Y. Simpson	Physician	59	1531
P. Dirichlet	Mathematician	54	1520
C. A. DeMorny	Statesman	54	1520
Daniel Webster	Statesman	70	1518
Lord John Campbell	Lord Chancellor, England	82	1517
Chauncey Wright	Philosopher	45	1516
M. Schleich	Writer and orator	55	1503
Thos. Chalmers	Theologian	67	1503
Garrick Mallery	Ethnologist and soldier	63	1503
Edward C. Seguin	Neurologist	55	1502
Napoleon III	Sovereign	55	1500
K. H. Fuchs	Pathologist	52	1499
Louis Agassiz	Naturalist	66	1495
C. Giacomini	Anatomist	58	1495
DeMorgan	Mathematician	73	1494
K. F. Gauss	Mathematician	78	1492
Ch. Letourneau	Anthropologist	71	1490
J. W. Powell	Geologist and ethnologist	68	1488
K. v. Pfeufer	Physician	63	1488
Wülfert	Jurist	64	1485
Paul Broca	Anthropologist	55	1484
G. de Mortillet	Anthropologist	77	1480
P. Aylett	Physician	58	1474
Lord Francis Jeffrey	Justice and editor	76	1471

TABLE I.—*Continued*

NAME	OCCUPATION	AGE	BRAIN-WEIGHT
L. Asseline	Journalist	49	1468
M. D. Skobeleff	General	39	1457
Ch H. E. Bischoff	Physician	79	1452
Hugo Gylden	Astronomer	55	1452
Lamarque	General	63	1449
F. R. v. Kobell	Geologist and poet	79	1445
Mihalkovicz	Embryologist	55	1440
H. v. Helmholtz	Physiologist	73	1440
Dupuytren	Surgeon	58	1437
P. A. Siljeström	Physicist and pedagogue	76	1422
Franz Schubert	Composer	70	1420
A. T. Rice	Diplomat and editor	35	1418
J. E. Oliver	Mathematician	65	1416
Melchior Meyr	Philosopher and poet	61	1415
Joseph Leidy	Morphologist	67	1415
Philip Leidy	Physician	53	1415
George Grote	Historian	75	1410
Nussbaum	Surgeon	61	1410
Joh. Huber	Philosopher	49	1409
C. Babbage	Mathematician and inventor	79	1403
Jules Assezat	Journalist	45	1403
C. v. Kupffer	Anatomist	73	1400
A. Bertillon	Anthropologist	62	1398
Fr. Goltz	Physiologist	68	1395
Coudereau	Physician	50	1390
Wm. Whewell	Philosopher	72	1389
Henry Wilson	U. S. Vice-President	61	1389
Rüdinger	Anatomist	64	1380
Szilagyi	Statesman	61	1380
H. T. v. Schmid	Litterateur	65	1374
A. A. Hovelacque	Anthropologist	52	1373
T. L. W. v. Bischoff	Anatomist	76	1370
K. F. Hermann	Philologist	51	1358
Justus v. Liebig	Chemist	70	1352
v. Schagintweit	Naturalist	51	1352
J. P. Fallmerayer	Historian	71	1349
John Hughes Bennett	Physician	63	1332
Max v. Pettenkofer	Chemist	82	1320
Seizel	Sculptor	50	1312
J. G. Kolar	Dramatist	84	1300
R. E. Grant	Astronomer	80	1290
Walt Whitman	Poet	72	1282
Robert Cory	Physician	55	1276
Edouard Seguin	Psychiatrist	68	1257
Fr. Tiedemann	Anatomist	79	1254
v. Lasaulx	Philologist	57	1250
Laborde	Physiologist and anthropologist	73	1234
L. v. Buhl	Anatomist	64	1229
J. F. Hausmann	Mineralogist	77	1226
B. G. Ferris	Jurist	89	1225
F. J. Gall	Anatomist and phrenologist	70	1198

nationality, body-weight and build, etc., cannot well be considered in these cases ; the necessary data are insufficient for the purposes

of a critical estimate of these influences. Marshall has essayed to do this with the brain-weights of Thackeray, Grote, Grant, Babbage, and De Morgan.

In the writer's list are tabulated the brain-weights of one hundred notable persons. Three others since obtained have been omitted, as the round number is more convenient to handle in the

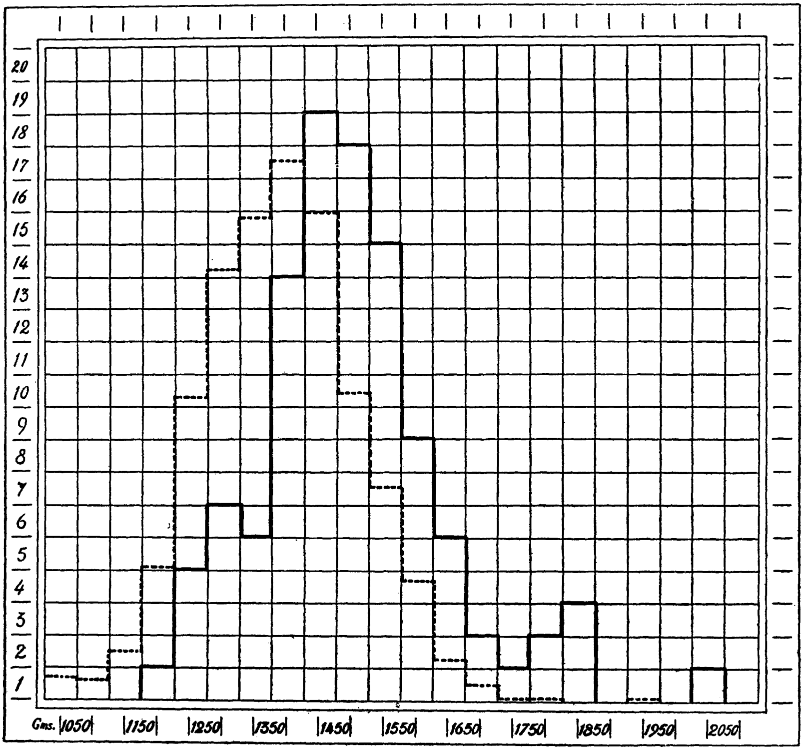

FIG. 32.—Chart showing the relatively greater number of heavier brains among the (100) "eminent men" (solid line), as compared with the distribution of the ordinary brain-weights of the combined series (1334 cases) of Bischoff, Retzius, Marchand, and Topinard, tabulated, for convenience in comparison, on the basis of 100 cases.

analysis. They are those of Major J. B. Pond, the well-known lecture-manager, age 65, brain-weight 1407 gms., after one day in weak (50 percent) alcohol, and two days in 10 percent formal; Johann Zeyer, of Prague, architect, age 56, stature 174: the brain weighed after being dissected and drained 1310 gms., autopsy by

Professor Hlava; Georg Bittner, dramatist, age 57, stature 173, brain-weight immediately after removal, 1556 gms., autopsy by

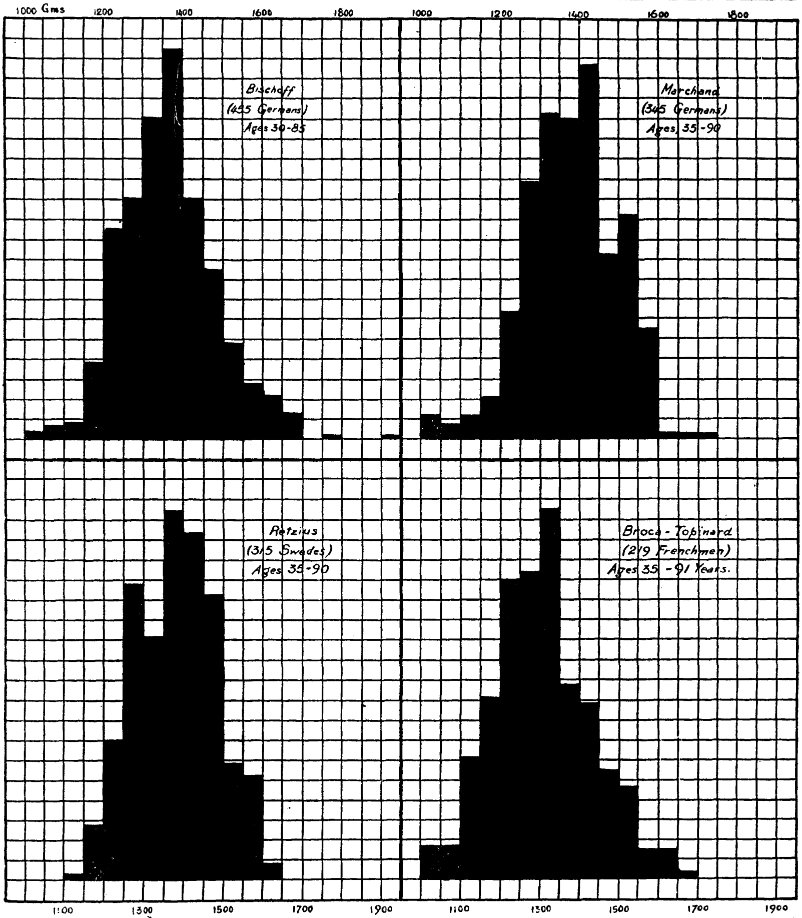

FIG. 33.—Charts showing distribution of brain-weights in the Bischoff (455 cases), Marchand (345), Retzius (315), and Topinard (219) series, each tabulated on a basis of 100 cases.

Professor Hlava. The last two brain-weights were communicated to the writer by Dr Matiegka, of Prague.

In the diagram (figure 32) is shown the range and distribution of these one hundred brain-weights as compared with similar com-

pilations of brain-weights of ordinary or average persons, use being made here of a composite diagram based on the series published by Bischoff, Retzius, Marchand, and Topinard, each series being shown in detail in figure 33, the total number of cases being 1334.

In order that the comparison with the eminent series may be a fair one, only those individuals who range between 35 and 90 years

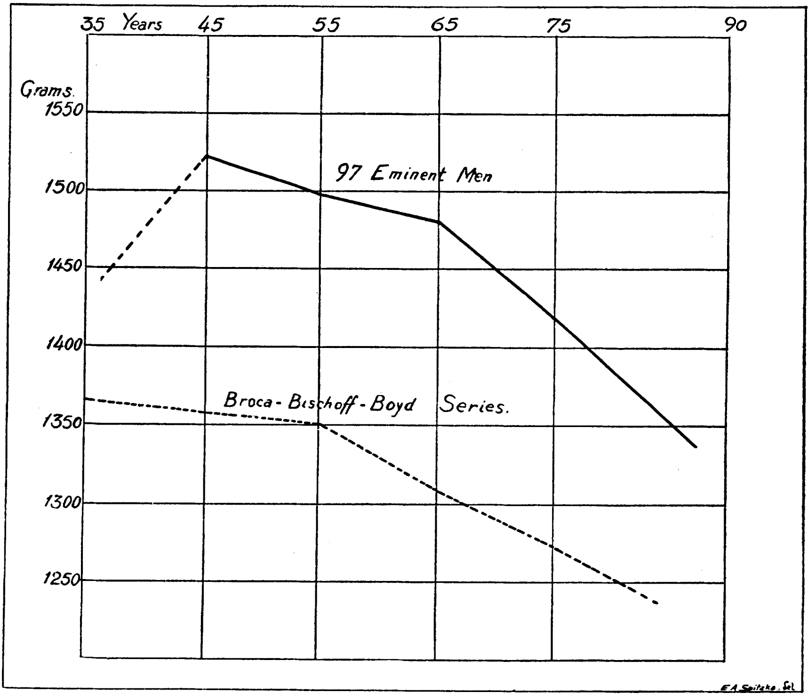

FIG. 34.—Curves of average brain-weights per decade in the series of (97) "eminent men" whose ages are recorded in Table I, compared with the Broca-Bischoff-Boyd series. The curves show the eminent men to be higher in the scale, and further that the senile decrease occurs a decade later than in the "ordinary" series.

of age (excepting Bischoff's series, in which the range is 30 to 85 years) were chosen, for only one of the notable persons, Konstantinoff, is younger. The diagrams show the number of cases per hundred in periods of 50 grams. It is readily seen that there is a relatively greater number of heavier brains among the hundred eminent men; the whole series is moved distinctly upward in the

scale,[1] as is also shown in the curves in figure 34. This latter chart also shows that in the eminent series the senile decrease occurs about a decade later than in the "ordinary series," a fact not without significance in relation to the well-known longevity of geniuses.

To sum up the results in brief, it is shown that the average (arithmetical) brain-weight of one hundred noted individuals is 1469.65 gms., with an average age (97 cases) of 62.4 years. Considering the age of these persons, their brain-weight exceeds the averages generally given for the European brain by more than 100 grams.

In proceeding to a further analysis it seems best to distribute these men of eminence among the three categories of Science, Creative Arts, and Action. In submitting these lists the writer feels constrained to repudiate any intention of maintaining the classification adopted to be one meeting all the requisites involved. The simple division into representatives of Science, Creative Art, and Action is necessitated by the smallness of numbers; a proper rubrication would leave more than one important division represented by only one or two individuals. Aside from the failure of three groups to provide for the various branches of mental activity as manifested in various professions—here conventionally adopted—it were doubtful whether mature reflection would endorse such classification. The latter is far from being a natural one, for it does not regard the intrinsic physiological relations of the professions, arts, and sciences. For example, the sharp demarcation of Art and Science leaves music and mathematics abruptly and remotely separated; yet whatever justifiable presumption exists as to the relations of cortical fields would assign both to closely situated, nay, in almost identical areas, tracts, and neurones of such. Again, to place, for example, generals in one group, is to throw in a chaos of unrelated units the mathematical genius, the geographical explorer, the expert physicist, with the strategic adventurer and opportune gambler of the battlefield chess-board.

With these reservations and limitations I call attention to the

[1] A study of the recorded cranial capacities of notable persons (62 in number) gives similar results.

table in which the results of such a classification are given in condensed form:

TABLE II

CATEGORIES	NUMBER OF CASES	AVERAGE AGE	AVERAGE BRAIN-WEIGHT
I. *a*, Exact Sciences	12	67.6	1532
b, Natural Sciences	48	63.8	1440.0
(All Sciences)	(60)	(64.5)	(1456.6)
II. Fine Arts, Philosophy, etc.	26	59	1485.0
III. Men of Action (government, politics, military, etc.)	14	65	1490.0
	100	62.4 (97 cases)	1469.65

It is readily seen that the representatives of the exact sciences, such as mathematicians and astronomers, possess the heaviest brains; in the present series, twelve in number, all have brain-weights of over 1400 grams, except the very aged Grant. Next come those in the category of "Men of Action," *i. e.*, statesmen, politicians, and military men. The "Creative Arts" come next, including among others three opera composers (Levi, 1690; Lenz, 1636; Schubert, 1420), with an average of 1582 grams. The average of 48 representatives of the Natural Sciences is the lowest of all, but is still well above the average of ordinary brain-weights. In this category a further analysis brings out significant facts: We find seven anthropologists and ethnologists averaging 64 years of age with 1459.3 grams; eleven anatomists and surgeons of the same age with 1433 grams; while six morphologists and naturalists (Cuvier, Cope, Agassiz, J. Leidy, and v. Schlagintweit) average 1519 grams. All the figures here collected show that, in general, the intellectual status is in some way reflected in the mass and weight of the brain; but further than this, our analysis shows that the brains of men devoted to the higher intellectual occupations, such as the mathematical sciences, involving the most complex mechanisms of the mind, those of men who have devised original lines of research (Cuvier, Cope), and those of forceful characters like Benjamin F. Butler and Daniel Webster, are among the heaviest of all. The results are quite as much in accord with biological results

as the fact that brachycephaly and increased cranial capacity in the most progressive races are in direct and intimate relation to each other. No less significant is the fact that in the primate series we find the higher anthropoids not further removed from the lower races of man with respect to brain-weight, both absolute and relative, than are the latter from a number of men of superior intellect in the white race. The jump from a Cuvier or a Thackeray to a Zulu or a Bushman is no greater than from the latter to the gorilla or the orang, as a glance at the following short list will show:

	Brain Weight in Grams	Approximate Ratio
Turgeneff	2012	1.0
Cuvier	1830	
Ben. Butler	1758	
Thackeray	1658	
Zulu	1050	0.5
Australian	907	
Bushwoman	794	
Gorilla	425	0.25
Orang	400	
Chimpanzee	390	

A gradation is easily demonstrable within the human species, for we may have cranial capacities ranging from about 2000 cc. in some of our most eminent men to less than 1000 cc. in the lowly Hottentot or Florida Indian (Hrdlička). The passage to the anthropoids, however, is undeniably abrupt, though we already have supplied to us a stepping-stone in the *Pithecanthropus* of Dubois.

Before I dismiss the subject of brain-weight I will refer briefly to a popular misconception concerning the make-up of the human brain. One often hears it said of an intellectual man, "he has lots of gray matter" To be sure, the statement is true enough, but not in the sense commonly implied. The brain of man is characterized more by its preponderance of white matter over that of gray matter than for its preponderance of gray matter over the gray matter of the lower animals, excluding perhaps the larger whales and the elephants. The value of arriving at a true estimate of the importance of the ratio of white and gray matter has been greatly enchanced by Flechsig's recent researches. To quote a high authority on this subject (E. C. Spitzka):

"White matter means elaborated and individualized projection of gray matter, as a multitude of parallel telegraph wires means a multitude of stations. If the telegraph wires are in number out of proportion greater than the number of stations, it means a more intricate inter-connection of station to station. Such inter-connection, however, involves a greater amplitude of stations. Therefore the greater the relative preponderance of alba (white matter) over cinerea (gray matter) the higher the intelligence; . . . the more numerous the dendrons, the greater the elaboration and individualization of the neuron. The human brain is more remarkable for its preponderance of alba over cinerea than for its cinerea preponderance over the cinerea of other animals. I would call the order: *Alligator*, *Didelphis*, *Canis*, *Macacus*, *Troglodytes*, *Homo*, a mathematical progression as regards the cinerea, a geometrical one as regards the alba. . . ."

Let us now turn our attention to the surface appearances of the cerebrum. As every one knows, the cerebral surface presents alternating depressions or fissures demarcating the convolutions or gyres. The surface pattern of these fissures and convolutions presents the same general features in all normal human brains, and, to some extent, in those of the higher anthropoids as well. When we come to make more careful comparisons, however, and delve more deeply into the details of fissural and gyral arrangement, we come to recognize many differences, not only in the brains of races and of different individuals, but also in the two cerebral halves of the same individual. When we endeavor to trace the stages of development of man's brain from that of his pithecanthropoid ancestor (insofar as the modern anthropoids afford a means for comparison), we observe how, in a number of ways, and, let us say, in consequence of the demands of evolution, certain regions of the cerebrum assume a greater energy of growth. The cortical expanse of any given area increases with the rise in functional dignity of that area. This is what happens in those regions of "unstable equilibrium" which exhibit the greatest range of variations when brains come to be compared. Such regions, expanding within the cranium, will form more folds or convolutions, spread over a greater area, with an increased number of intervening fissures. The fissures in themselves are not of such paramount importance except insofar

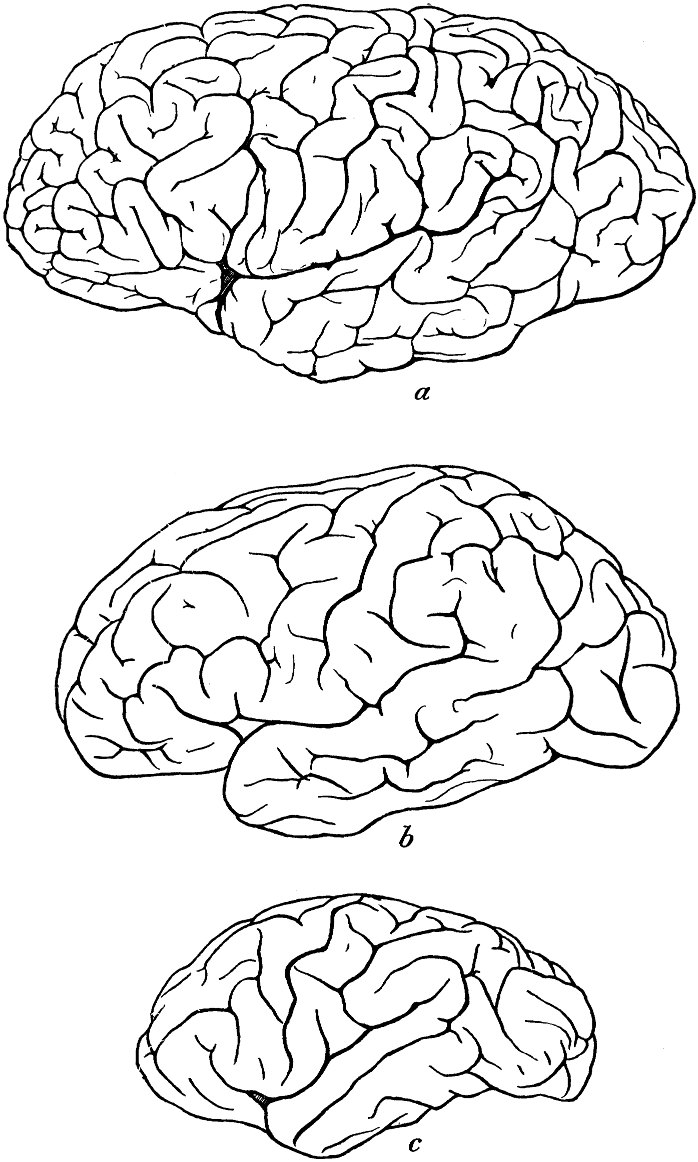

FIG. 35.—*a*, Brain of Gauss, mathematician (after Wagner). *b*, Brain of a Bushwoman (after Marshall). *c*, Brain of gorilla (D. 658, Mus. Roy. Coll. Surgeons of Eng.).

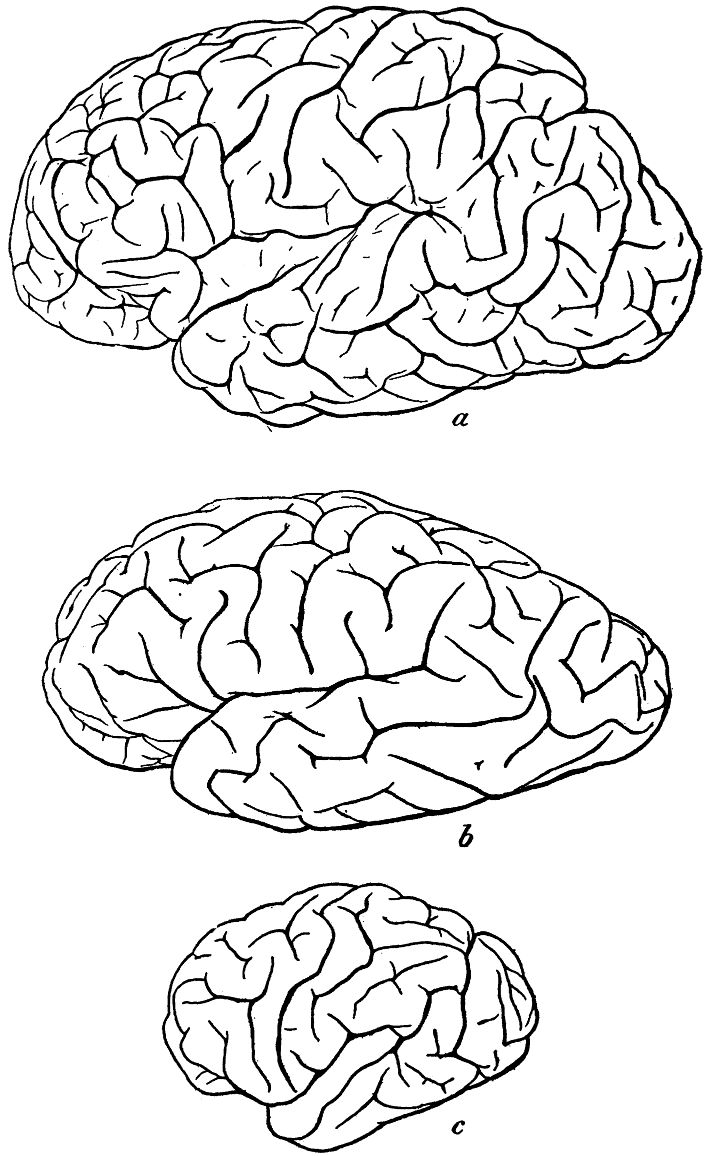

FIG. 36.—*a*, Brain of Helmholtz (after Hansemann). *b*, Brain of a Papuan (drawn by the author from a specimen in the Anatomical Museum, Columbia University). *c*, Brain of chimpanzee (after Flatau and Jacobson).

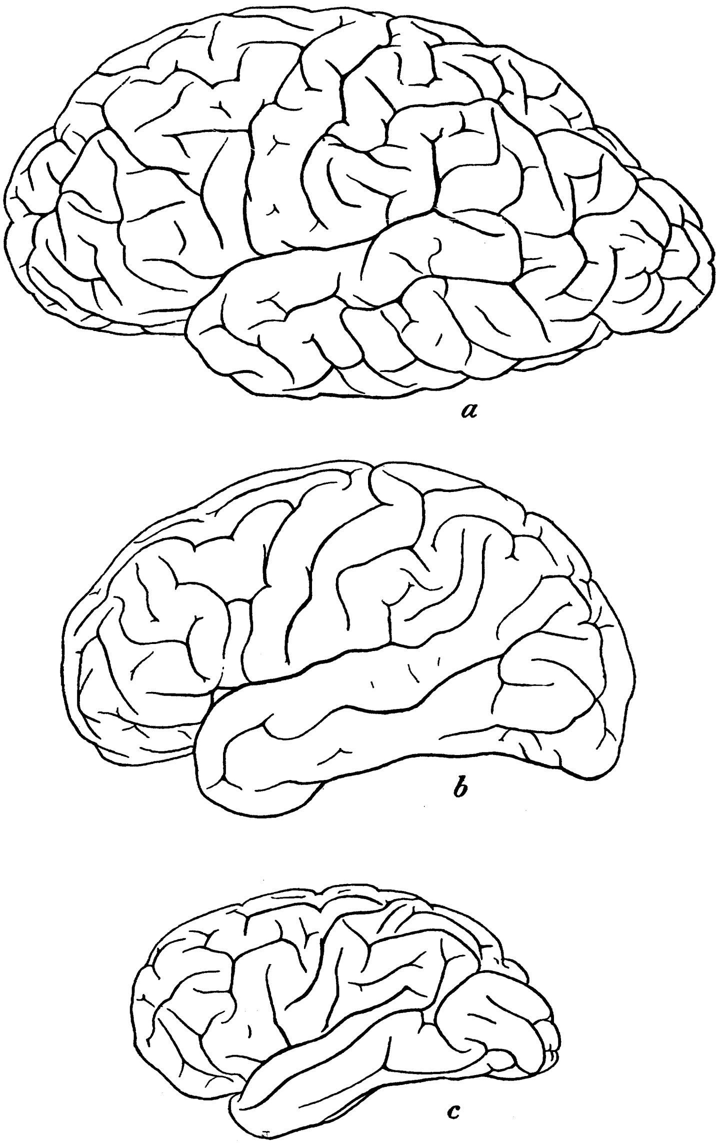

FIG. 37.—*a*, Brain of Siljeström, physicist and pedagogue, also mathematician (after Retzius). *b*, Brain of "Sartjee," or "Hottentot Venus" (after Gratiolet and Bischoff). *c*, Brain of orangutang "Rajah" (drawn by the author from specimen kindly loaned by Dr Harlow Brooks).

as they facilitate the mapping of the cerebral regions under consideration and serve as a useful index of the degree of development. In this light, fissuration would seem to be merely the result of mechanical packing or folding of the cortex; as to the regular appearance of the typical fissures, however, the hereditary factor must not be forgotten.

The fact that certain portions of the cerebrum exhibit different degrees of growth-energy is unquestionably of considerable importance from the neuro-physiological point of view. The higher anthropoids and man possess many points in common as regards

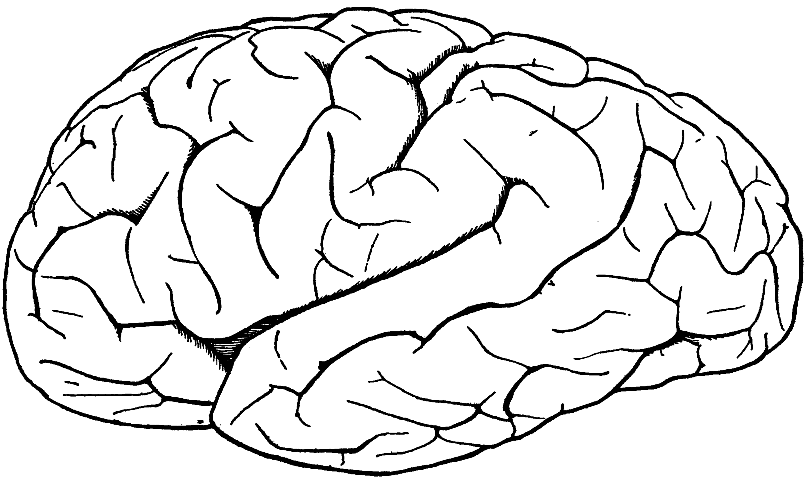

FIG. 38.—Brain of Chauncey Wright (after B. G. Wilder).

structure, habit, mode of life, etc. But over and above these traits man possesses an associative memory, or ability to store and compare sensations, far greater than that of the highest ape; and this supremacy finds its expression, beyond peradventure, in the greater size and complexity of structure of man's brain. But this superiority in structure and size is not merely a uniform expansion of the brain as a whole, but rather of certain portions of it; and just as the differences, for instance, in the extent of the sense-areas throughout the animal series will be seen to be in conformity with the peripheral areas with which they are in connection, so will it be seen that the chief characteristic of the human brain is the im-

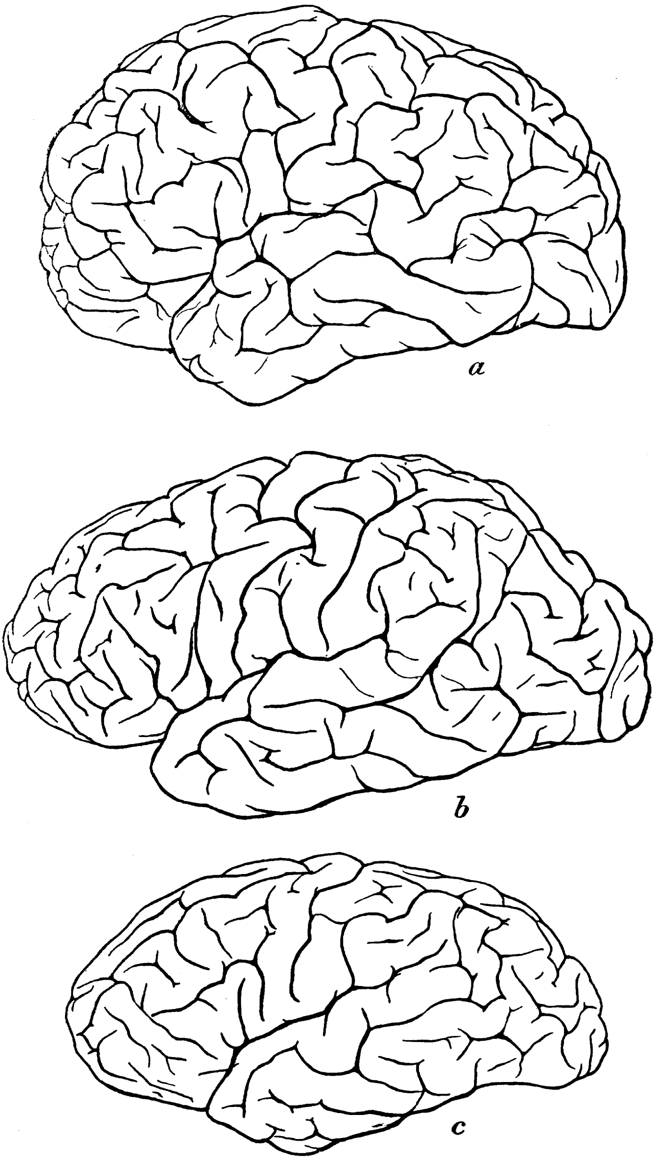

FIG. 39.—*a*, Brain of General Skobeleff (after Sernow). *b*, Brain of Professor Altmann, anatomist (from photograph kindly sent by Dr P. Năcke, of Hubertusburg). *c*, Brain of Gambetta (after Duval).

mense extent of the cortical association areas and tracts. At a rough estimate it may be said that the association areas constitute two-thirds of the human cerebral cortex, while only the remaining third, taking the somæsthetic and sense-areas together, is provided with projection fibers chiefly.

But as it is in the association areas (hitherto termed the "silent areas" because, forsooth, we understood them not) that the higher intellectual activities are carried on, it is in these portions of the cortex that the higher feelings assume shape and control or influence the somæsthetic areas with which they are connected. Herein it is that the mind of man differs most from that of the brute. To a slighter yet palpable degree the same differentiation may be made in comparing human minds with one another (figures 35 to 39). That is why such intellectual giants as Gauss and Helmholtz possess brains superior not only in total size as well as in the development and arrangement of the convolutions, but in special cortical fields in particular; in other words the greater area and complexity of the cortical expanse is an expression of the degree of refinement which characterizes the mentality of the individual. One is fairly tempted to say that the contrast between such a brain and that of a Hottentot or a Papuan is as great, if not greater than that between the Hottentot's brain and the brain of a chimpanzee or an orang. The more experienced we become in the examination of brains, the more convinced are we that the external appearances of the cerebrum often give the best indication of the individual's psychic powers. The recent morphological studies of Retzius on the brains of Gylden, Kovalewski, and Siljeström, of Hansemann on that of Helmholtz, of Guszman on that of Rudolf Lenz, of Duval on that of Gambetta, of Papillault on that of Laborde, of Rüdinger on those on several men of science and scholars, and of those by the writer on the two brains of the Seguins, father and son, tend to show that the index of an individual's prominent characteristic is to be found in certain individual peculiarities in the development of one or another cortical region. If the older investigators had been disappointed in their search for definite areas of differentiation in different brains, it had been because there did not yet prevail a thorough appreciation of the complex and but recently understood

mechanisms involved in cerebration, and because of the limited knowledge of cerebral topography.

The evidence that has been gathered by the observers above mentioned, while arguing for territorial differentiation of the cortex, has, as a supplement to the anatomical investigations of Flechsig, furnished us with a comprehensive understanding of certain distinctions between brains of high and of low order. The unusual simplicity of the surface-markings of the brain of Chauncey Wright (figure 38) seems paradoxical and clearly affords the exception that proves the rule. Although we possess but few data as to the ideal average or "standard" pattern of the human brain (the necessity of obtaining which Professor Wilder, of Cornell, has constantly urged us to keep in the public mind), this case is exceptional enough to command attention. Whether the fissural simplicity and gyral width and flatness (not to mention a rare fissural atypy; bilateral interruption of the central f.), "are family characteristics or correlated with Wright's mental and physical deliberateness, light may be thrown upon the problem by the conditions to be observed in his blood-relations or in similarly 'slow but sure' in thought, speech, and act."[1] His slowness of speech and action was very notable; he was large in person, as was Turgeneff, of whose brain it is said that gyral width and bilateral symmetry was marked. That such brains are exceptional seems a safe conclusion to make, even though the number of detailed observations is not very large. In other words, experience teaches us that there is a physiognomy of brain which portrays intellectuality quite as often as does the outward physiognomy. That this so-called cerebral physiognomy is difficult to describe in so many words, or that we are occasionally deceived by it, does not alter the fact that we may learn (generally) to recognize and to judge it. Patient study on a greater amount of suitable material may in the future enable us to express in scientific terms what is now a mere personal conviction. The thought ever recurs to us in such studies: What a pity that we have not the brain of a Newton, a Shakespeare, a Michelangelo, a Beethoven, or an Edgar Allan Poe! How much more useful would be the study of such organs of thought; how elevating, how

[1] Wilder in *Jour. Nerv. and Ment. Dis.*, 1896, p. 706.

inspiring would their lessons be. Hitherto, however, we have examined, almost exclusively, the brains of pauper ne'er-do-wells and criminals.

For purposes of comparison certain measurements of the brain will be found very useful. Of course, the measurement of the brain is rendered a difficult procedure by numerous disturbing factors, depending chiefly on the softness of the organ when fresh, and upon the changes wrought in the process of hardening. A number of systems of measurement have been proposed, but not all of them have stood the test of time and critics. For my own part I find those measurements best which can be reduced from actual to relative values, wherein some unit of length (preferably the maximum hemicerebral length) is used as a basis of expression rather than so many inches or centimeters. Hence I prefer to use centesimals of the hemicerebral length, and by making such records of various brains their comparison with each other becomes comparatively easy. The best ways of measuring the brain are those proposed, among others, by Cunningham, Marshall, Broca, Dide and Chenais, Chiarugi, Giacomini, and Hrdlička. No one of these quite fulfills all the demands for a comprehensive system, and I have hence provisionally chosen those that seemed most desirable to employ and which covered the most salient points. Of course, any method of measurement cannot be safely employed except on brains which have not suffered distortion in the process of hardening.

I will call attention only to a few of the more important methods of measurement which readily afford a means of understanding the relative expanse — be it a preponderance or a reduction — of the lobes of one side as compared with the other, or of one brain as compared with another brain. A plane is selected which passes through the ventral borders of the frontal and occipital poles (figure 40; the base-line is drawn parallel to this arbitrary horizontal plane). To this base-line are drawn ordinates from the cephalic and caudal points, giving in the abscissa the hemicerebral length; this distance is divided into 100 parts or centesimals. Other ordinates are drawn from (1) tip of temporal pole, (2) junction of the presylvian ramus with the sylvian fissure, (3) ventral end

of the central fissure, (4) junction of the episylvian ramus with the sylvian fissure, (5) on the mesal surface, (6) the cephalic border of the callosum, (7) the porta of foramen of Monro, (8) the dorsal end of the central fissure, (9) the caudal border of the callosum, (10)

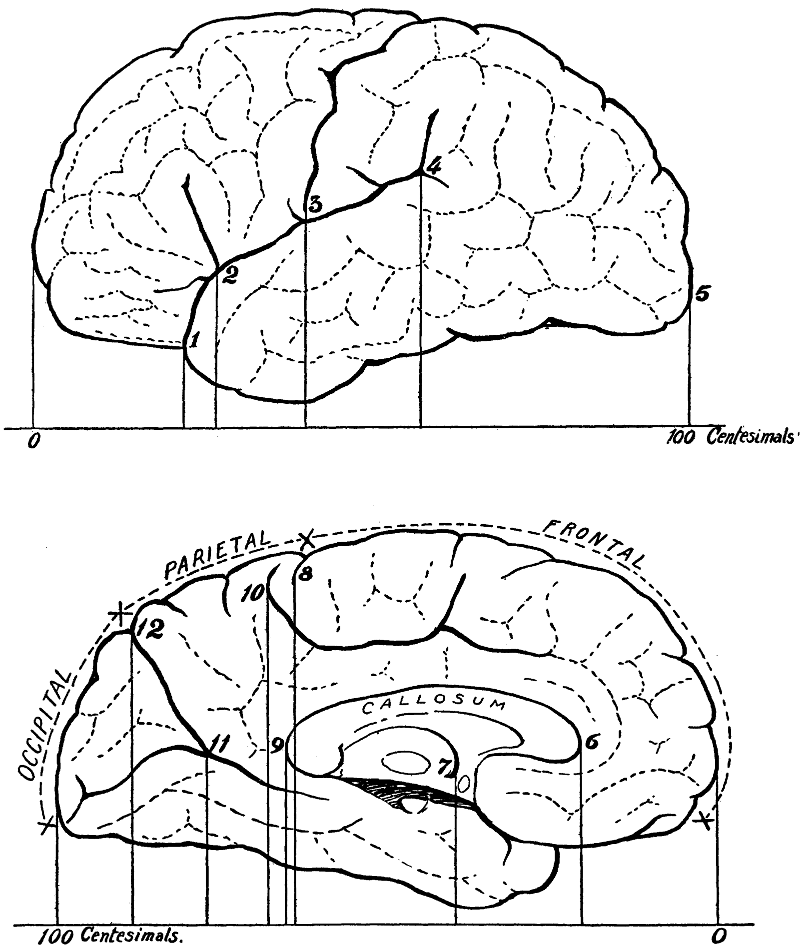

FIG. 40.—Showing some useful methods of brain-measurement.

the dorsal intersection of the caudal paracentral ramus, (11) the junction of the occipital and calcarine fissures, (12) the dorsal intersection of the occipital fissure. The arc measurements of Cunning-

ham, giving the frontal, parietal, and occipital indices, are also indicated in the lower illustration.

Another method which I have found useful, and one which gives a better understanding of the relative size of the frontal lobe as compared with the parieto-occipital areas, consists in cutting out and weighing pieces of sheet-lead of the same size as the mesal surfaces of (*a*) the frontal and of (*b*) the cuneus and precuneus combined. The ratios which these bear to each other differ more or less in different brains, and while I have applied the method to a comparatively small number of brains, such results as I have obtained have more than confirmed my anticipations and encourage me to further extend my researches in this direction. Of two brains of notable persons — one a scholar whose mentality was characterized by the great powers of abstract thought, the other a man of science of unusual observational powers — the frontal lobe predominated considerably in the former, the parieto-occipital area in the latter. Of course the mesal surface only is considered.

This leads me to the discussion of the differentiations of certain cortical areas and their relation to the doctrine of cerebral localization. The history of the evolution of an *Archipithecus* into a *Pithecanthropus* and finally into Man has essentially been the history of a progressive development of the brain, accompanied by the attainment of the erect position and the development of language, abstract thought, and reasoning. When we come to consider the complex anatomy of the human brain, it will be found that the acquisition of these mental functions — language, abstract thought, ideation, and reasoning — have been the chief factors in bringing about its superior structure, and that any given region of the cortex gains in functional dignity with the increase of its associations. When we remember that the cortex of the larger brain of man contains, in round numbers, 9,200,000,000 functional nerve-cells, we need not wonder at man's capacity for the manifold registration of sensations and the numerous transformations that characterize his mental processes. With the increase of knowledge, especially in civilized times, each generation has added its increment; the laws of natural selection provided for the perpetuation of the superior brains with the gradual extinction of the feebler.

In discussing a subject so far-reaching and comprehensive in scope as this, it is impossible to treat adequately all its parts in a paper of this length. Let us consider, therefore, only some of the more important psychical functions of the brain — for instance, that of the faculty of speech.

Speech, as Huxley has said, is perhaps the "most human manifestation of humanity," and there is no question that the acquisition of this faculty "has afforded the chief stimulus to the general development of the brain." To quote from Professor Cunningham's address before the British Association (1901): "Some cerebral variation, probably trifling and insignificant at the start, yet pregnant with the most far-reaching possibilities, has, in the stem-form of man contributed that condition which has rendered speech possible. This variation, strengthened and fostered by natural selection, has in the end led to the great double result of a large brain with wide and extensive association areas and articulate speech, the two results being brought about by the mutual reaction of the one process upon the other."

Let us examine briefly the evidences of cerebral research which bear upon brain-centers directly concerned with the speech faculty.

In the first place, the center for articulate speech has been localized in the subfrontal gyre (or "Broca's gyrus"), in the left hemicerebrum of right-handed persons, and in the right side in left-handed persons. Why this faculty should be confined to the left side of the brain in right-handed persons is yet a matter of debate; it seems to be largely a matter of inheritance — a transmission of functional preëminence as regards associated motor innervations in the left brain. Nearly all observations upon this region agree in ascribing a superior development with reference to size and differentiation in the brains of intellectual persons. Notable cases are those of the orator Gambetta (described by Duval), Professor Laborde (by Papillault), two professors of the University of Freiburg (by Waldschmidt), a number of jurists and lecturers of Munich (by Rüdinger), and the younger Seguin (by Spitzka). Further than this, Rüdinger, Schwalbe, v. Kupffer, and others have found the corresponding region in the skulls of eminent men (Wülfert, Huber, Kant) to bulge much more on the left than on the right side.

A region which I believe, however, to be of not a little importance with reference to the intellectual powers, and of speech in particular, is the insula. This is perhaps the purest association center in the brain, serving to connect the various receptive sense-areas related to the understanding of speech with the somæsthetic emissary centers. This region, usually neglected by most investigators, has been examined with care by the writer, and it has been found that, as a rule, in the brains of intellectual persons, not only is the left insula the larger and more differentiated, but, more than this, the preinsula, which is in close juxtaposition to the cortical center for articulate speech, is most redundant. And the more a man be a gifted dialectician, the more demonstrable does this redundancy seem to be. The appearances in the two Seguin brains were exceedingly interesting. The left insula in both was the better developed, and in the younger Seguin, whose linguistic powers were indisputably remarkable, the preinsular portion was so redundant that the surrounding opercular parts have been crowded apart and a small triangular portion of the insular pole is thus made visible on the lateral aspect. Of course, it were absurd to sustain the proposition by the experience of so few cases; but they strongly justify as a surmise, if not as a scientific probability, this anticipation: that hereditarily transmitted and identifiable individualities will be first satisfactorily determined in the insular district, and they point in the direction of the following logical chain: partly of obtained facts, partly of natural conclusions drawn from these.

In a study of heredity,[1] the results of which were placed at my disposal, covering the parentage and descent of individuals prominent in various fields of science, art, and handicraft, it is found that the cases where both father and son attained distinction sufficiently to merit place (in the biographical encyclopedias) in intellectual fields of labor, they had been of those in whom skilled motor innervations in their association with sensory impressions and registrations were prerequisites. Preëminently is this the case with two professions: that of the composer-musician and that of the philologist. As defects in speech are so likely to be repeated in a family line, it seems that its skilled employment by the ancestor is similarly

[1] By E. C. Spitzka.

reflected in the way of facile acquirability on the part of the descendant. Not unrelated may be the fact that among those recruited for the ranks of linguists of other than philologist parentage, there largely predominate those whose parents had emigrated or who were born on islands, in seaport towns, or in lands where two dialects are spoken, not to mention those in whose families it has been the custom to maintain an ancient tongue for sacerdotal reasons. The speech-faculty in its intimate relations to thought-expression, to memory, in its reading form to sight, in writing to manual muscular innervation, exquisitely hereditary as it is life, and most accurately localizable in the ravages of disease, as shown after death, appears one whose transmission is most likely to be expressed by morphological signs — be they relative and quantitative or purely morphological — and these in and about the island of Reil.

This brief exposition of some of the problems of cerebral investigation may serve to point the way in which present researches should be most vigorously pursued, and while no department of anatomical research is more difficult, the results which we may reasonably expect more than repay the efforts put forth.

III

On the death of Major Powell at Haven, Maine, on September 23, 1902, his remains were embalmed and brought to Washington. Dr D. S. Lamb performed the necroscopy on September 26, about sixty hours after death, the examination being limited to the head. The following is a brief extract from the notes taken at the time.

"Scalp quite adherent. Some adhesion of the brain to the dura. Right side of brain firm and blanched. Left side softer and retained color of blood-vessels. Embalming fluid had not apparently penetrated well. Blood-vessels markedly atheromatous; marked arterio-sclerosis. Brain-weight, 1488 grams. Brain placed in 10 percent formalin."

The weight of the brain, with the pia-arachnoid still attached, was found by Dr Lamb to be 1488 gms. or 52.5 ounces avoirdupois. After seven months' immersion in the preservative fluid (formal) the parts of the brain weigh :

Left hemicerebrum (without pia)	544 gms.
Right hemicerebrum (without pia)	525 "
Cerebellum (with pia)	127 "
Pons and medulla (with pia)	21
	1217 gms.

The loss of 271 gms. (18 percent) is due to the influences of the embalming and preservative fluids, and to the removal of the cerebral pia-arachnoid.

Remembering Major Powell's age (68 ½ years), his rather small stature and bodily build,[1] and the atrophy which accompanied the physical decline of the last year or so of life (not to mention the effect of the embalming fluid), the brain-weight, as recorded, is decidedly above the average, and was undoubtedly very much higher in the best years of his life.

The Cerebrum

The cerebrum exhibits a decidedly superior degree of fissural complexity with notable flexuosity of the gyres; particularly of the pre-frontal, parieto-occipital, and parieto-temporal areas. Signs of atrophy (from old age) are visible throughout, particularly in the somæsthetic areas. On the right side this atrophy is rather more extensive, going well into the occipital lobe. This half also weighs less than the left. The fissures in the motor area gape and the gyres appear somewhat shrunken. There are spots of softening in the right occipital lobe. Viewed dorsally, the cerebrum is seen to be of good breadth throughout, the maximum being at the marginal supertemporal transition. The left frontal lobe is not so squarely formed cephalad, but is a trifle wider and more massive than the

[1] As yet no accurate records of the stature and body-weight have been found. A group of friends of the late Major Powell made a number of estimates which were noted by Dr McGee. The first estimates were all high, but revised estimates were all lower after it had been pointed out that one of the peculiarities in Powell's personality was that of appearing to possess a greater stature than he actually measured. His stature may be taken as having been about 5 feet 6 inches. He regarded his normal body-weight as 165 pounds, though at one time he reached about 190. It must be remembered that this value was affected by the absence of the right arm. His hands and feet were small — strikingly so in contrast with the massiveness of his head; he ordinarily wore 6-E shoes, and his glove was proportionately small; his collar measure (loose) was 17½; his hats, as Dr McGee recalls, were either 7⅜ strong or 7½ scant, according to the range of the maker.

right. Viewed laterally, and comparing the two sides, the left subfrontal gyre is the better developed, *i. e.*, more superiorly differentiated from the common type than the same gyre on the right. The

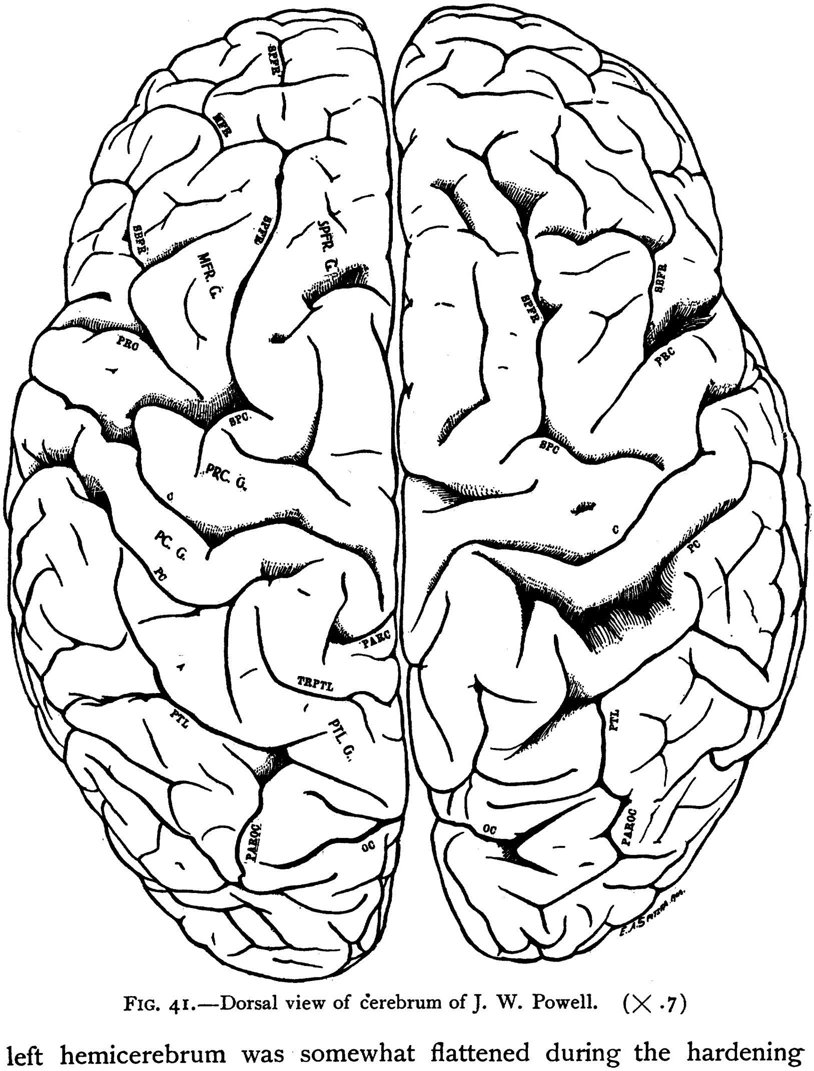

FIG. 41.—Dorsal view of cerebrum of J. W. Powell. (× .7)

left hemicerebrum was somewhat flattened during the hardening process. The most notable difference observable between the lateral views of the two halves lies in the greater extent of the parieto-temporal transitional region on the right side. So great is

the redundancy of these areas that they have considerably encroached upon sylvian fissure, shortening it to 4.1 cm. (6.1 on the left). The table of horizontal distances appended to this descrip-

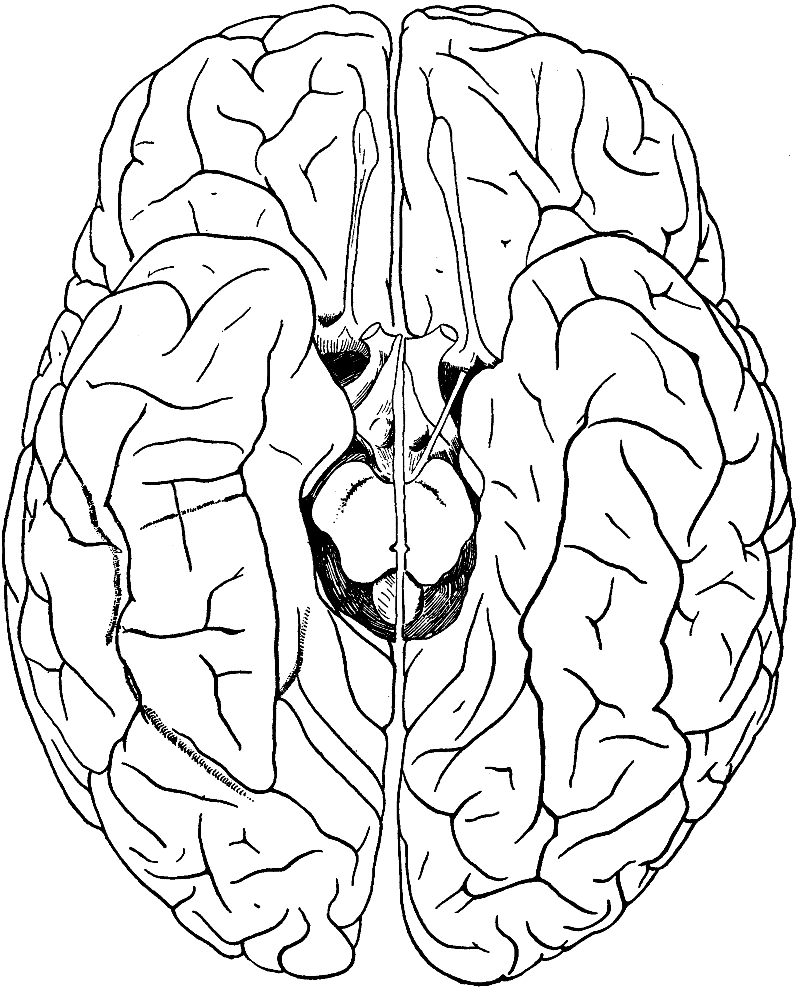

FIG. 42.—Ventral view of cerebrum of J. W. Powell. (× .7)

tion shows the junction of the sylvian with its episylvian ramus to be 12 centesimals (of the total hemicerebral length) further removed from the occipital pole on the right than on the left side. This feature will be discussed in detail in the sequel. A comparison of

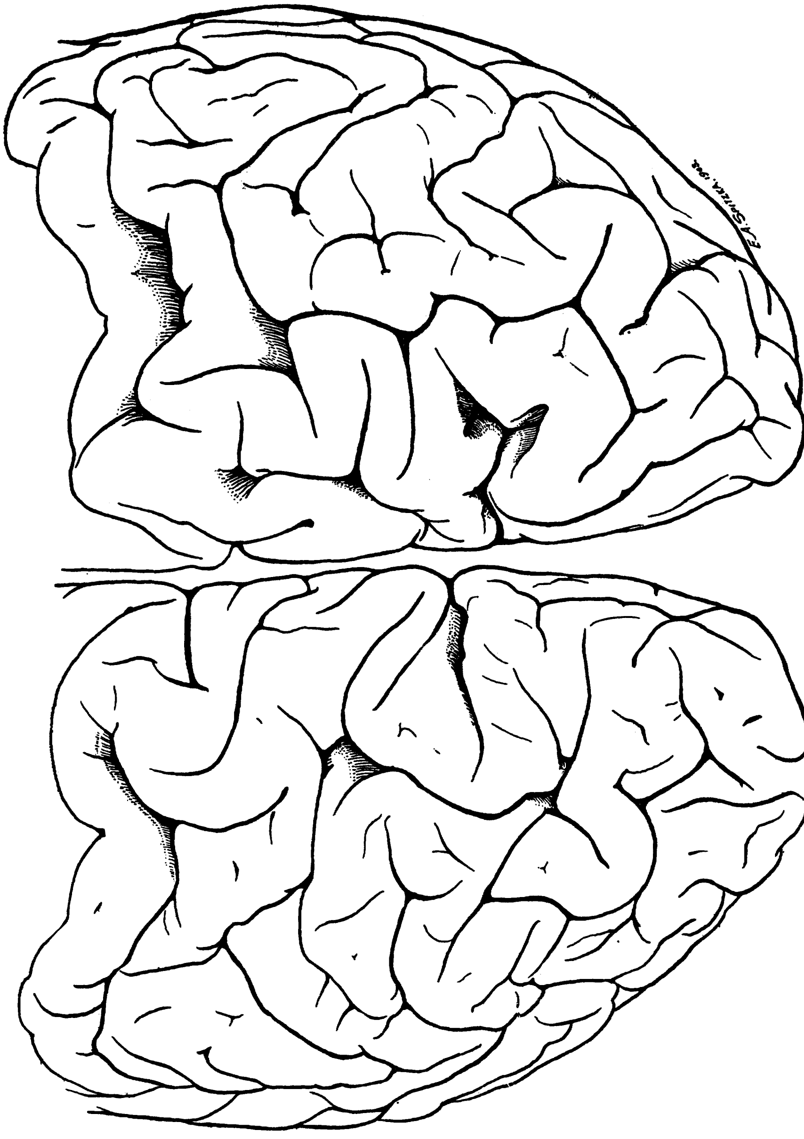

FIG. 43.—View of caudal parts of cerebrum of J. W. Powell. (Natural size.)

the mesal views shows the right frontal lobe (using the caudal paracentral limb as the boundary) to reach further caudad than the left. The combined area of the cuneus and precuneus of the right side is unusually small, owing in some measure to the high sweep of

the calcarine fissure. Pieces of sheet-lead, of uniform density and thickness, cut of exactly the same size as (*a*) the mesal frontal area, and (*b*) the cuneus and precuneus together, show, on careful weighing, the following proportions per 100 on the two sides.

	Left	Right
Frontal lobe,	65.6	70.6
Cuneus-precuneus,	34.4	29.4

Viewed ventrally, the temporal lobes are seen to be massive, the left being slightly longer. The impressions of the petrous bones have been preserved. Taking the cerebrum as a whole, neither half can be said to markedly preponderate over the other, except in respect to the greater extent of the subparietal regions of the right side. The amputation of Major Powell's right arm occurred at too late a period in life to effect any notable or positive changes in the naked-eye appearances of the motor region for this member. The loss of the limb was followed, without doubt, by degenerative changes in the spinal and cortical centers and the connecting nerve-tracts, but such changes can only be determined by a microscopical examination. This may be carried out some time in the future.

The epiphysis (pineal body) is unusually large.

Left Hemicerebrum

THE INTERLOBAR FISSURES

The Sylvian Fissure and its Rami.—The sylvian fissure is 6.1 cm. in length and pursues quite a tortuous course. Its angle with the plane here adopted (see above) is 15°. Its depths are:

Presylvian point,	15 mm.
Medisylvian point,	20 "
Postsylvian point,	29 "

The presylvian ramus is short and bifurcates; the subsylvian is also short and anastomoses with the radiate fissure. The episylvian ramus is 17 mm.; the hyposylvian 23 mm. in length. The basisylvian, measured from the tip of the temporal lobe, is 24 mm. in depth.

Central Fissure.—The central fissure, measured with a moistened string laid in its course, is 10.5 cm. in length and is quite

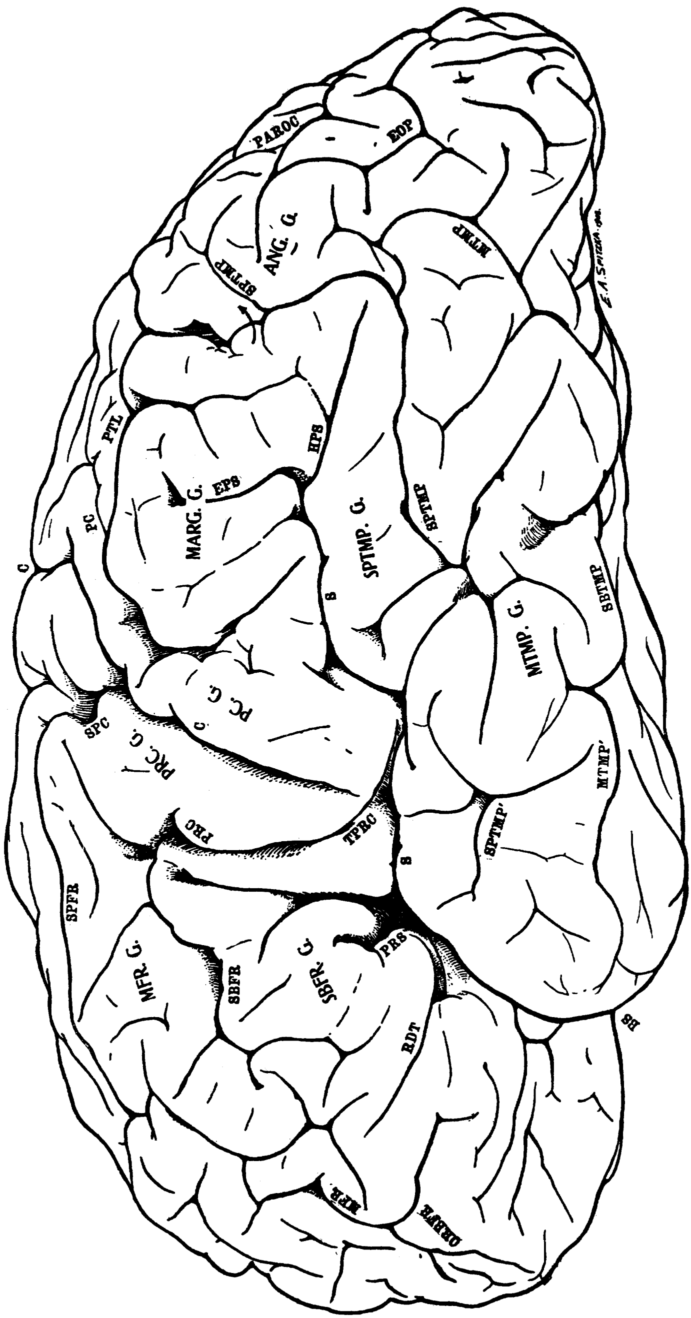

FIG. 44.—Lateral view of left hemicerebrum of J. W. Powell. This half is slightly flattened on the dorsum. (Natural size.)

sinuous, especially at the junction of its ventral and middle thirds. It anastomoses cephalad with the supercentral over a vadum 6 mm. in depth. The fissure is deepest (19 mm.) near this anastomosis.

Occipital Fissure. — The occipital fissure attains a length of 3.5 cm. on the meson, and 2.5 cm. on the dorsum. It is quite deep throughout and shows a number of well-marked subgyres in its depths. The intraprecuneal anastomoses with it superficially (vadum, 6 mm.) on the mesal surface.

Calcarine Fissure. — The calcarine fissure passes well caudad without interruption, attaining a length of 4.8 cm.

The occipital and calcarine meet at a depth of 20 mm. to pass into the occipito-calcarine stem, which is 3 cm. in length.

FISSURES OF THE FRONTAL LOBE

LATERAL SURFACE. *The Precentral Fissural Complex.* — The supercentral is of the usual zygal shape, freely continuous cephalad with the superfrontal, and anastomosing superficially, caudoventrad, with the central. Mesad of the supercentral, and helping to demarcate the superfrontal gyre from the precentral, there is a triradiate (paramesal ?) fissure. The precentral passes in the main parallel with the central, till, by its junction with the transprecentral it passes ventrad to dip slightly into the sylvian cleft.

The diagonal fissure is very deep, 2.5 cm. in length and passes deeply into the sylvian cleft. The superfrontal passes cephalad for 5 cm. and then joins the medifrontal laterad. Further cephalad there is a short, independent zygal superfrontal piece. Several paramesial segments mark the superfrontal gyre. The medifrontal fissure springs from the orbitofrontal, pursues a tortuous or rather zigzag course and anastomoses with the superfrontal. The subfrontal springs from the precentral, curves cephalo-ventrad in a sinuous manner and sends off numerous rami. The orbitofrontal forms a λ with the medifrontal as the stem, and attains a total length of 5 cm. The radiate is 2.5 cm. in length and anastomoses with the subsylvian.

MESAL SURFACE. — The supercallosal fissure is separated into two pieces, resembling the arrangement described by Manouvrier in the brain of Eugen Veron. The caudal, shorter segment passes

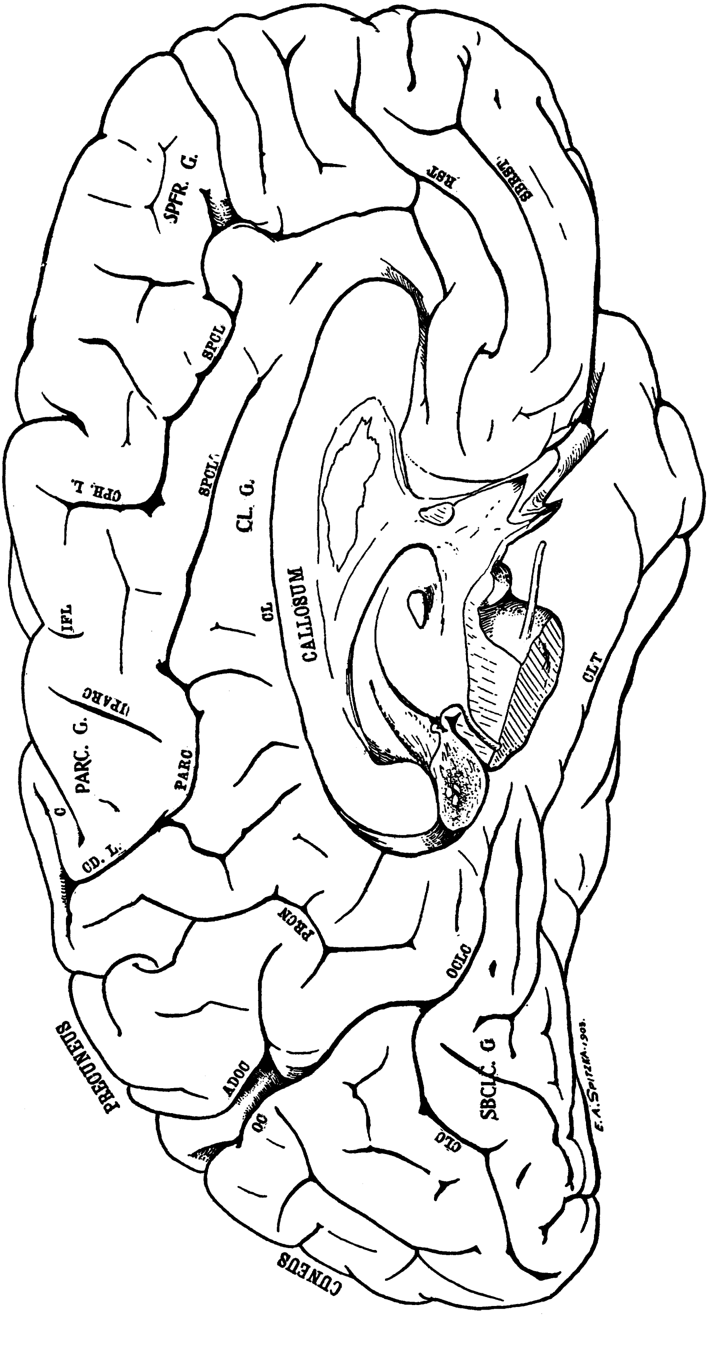

FIG. 45.—Mesal view of left hemicerebrum of J. W. Powell. Natural size. (Note the large size of the epiphysis.)

from the paracentral, with which it is confluent, well into the callosal gyre. The longer cephalic segment pursues a very tortuous course and sends off a number of rami. The paracentral is a simple curved fissure, terminating on the dorsum in a T-shaped manner by means of the opercular isthmus joining the postcentral and parietal gyres. The cephalic paracentral limb is separated from its stem, remaining joined to the cephalic supercallosal segment, an arrangement noted by the writer in 14 out of 160 hemicerebrums.[1] Only a shallow groove marks the usual site of the inflected fissure. There is a well-marked rostral fissure.

ORBITAL SURFACE. — The orbital fissure is of typical zygal shape, with transversely directed stem. Three other independent orbital segments mark this surface. The olfactory fissure is 4.8 cm. in length.

GYRES OF THE FRONTAL LOBE

LATERAL SURFACE. — The precentral gyre resembles that of the right side in the general configuration and form as well as in the partial interruption by the anastomosis of the supercentral with the precentral. Compared with the postcentral gyre it is much larger and more massive in all respects, and is particularly broad in its middle and ventral thirds. The superfrontal gyre is of good breadth throughout and marked by several fissural segments. The medifrontal gyre is of good width (2–3 cm.) and marked by numerous fissural segments and rami of adjoining fissures, mostly transverse in direction. The subfrontal gyre, compared with that of the right side, is a trifle more differentiated from the common type, but otherwise resembles it in size and general shape.

MESAL SURFACE. — On the meson the superfrontal gyre is of greater area and is more richly fissured, particularly by transverse segments, than that of the right side. The paracentral gyre is long, but less broad than its fellow on the right side, and joins the callosal gyre by means of the oblique isthmus interposed between the two supercallosal fissural segments.

ORBITAL SURFACE. — The orbital surface is a trifle broader and a little more intricately convoluted than that of the right side.

[1] Spitzka, E. A., "The Mesal Relations of the Inflected Fissure. Observations upon One-hundred Brains," *N. Y. Med. Jour.*, January 5, 1901.

FISSURES OF THE PARIETAL AND OCCIPITAL LOBES

Lateral Surface. — The postcentral segments are confluent, forming a long (9 cm.), sinuous, and deep fissure which bifurcates dorsad, anastomoses superficially with the parietal, and sends off a few short rami. There is a short transpostcentral. The parietal, 5 cm. in length, anastomoses cephalad with the postcentral over a shallow vadum, caudad with the paroccipital, and in its course is also joined by the intermedial. The paroccipital fissure is of irregular zygal shape; the stem is 3 cm. long, the cephalic and caudal stipes are longer than the corresponding rami. The parietal joins the very short cephalic ramus at a depth of 11 mm. There is a post-paroccipital, and, cephalad of the occipital and anastomosing with it, a fissure which may represent the adoccipital which is sometimes better marked in other brains.

The exoccipital complex is very difficult to analyze. One segment is readily recognized as the "occipitalis lateralis" of the older authors, but nothing definite can at present be said about the other fissures in the neighborhood other than that they tend to a transverse course.

Mesal Surface. — The precuneal fissure is irregularly zygal and independent of neighboring fissures. There are several intraparacentral pieces; one anastomosing with the paracentral. The cuneus is marked by a well-developed postcuneal, and by shallow segments of the cuneal fissure.

GYRES OF THE PARIETAL AND OCCIPITAL LOBES

Lateral Surface. — The postcentral gyre is narrow and quite tortuous. The parietal is notable for its great width in the cephalic portion, and is on the whole more extensive than the corresponding region on the right side. The paroccipital gyre, like its fellow, is richly convoluted and of good size. The divisions of the subparietal, taken together, occupy a lesser area than the subparietal regions on the right side. The angular gyre is notably small, but aside from this difference the two sides agree in being much more complexly convoluted and more intricately fissured than is shown in average brains.

Mesal Surface. — The cuneus is larger than that of the right

hemicerebrum, as is also the precuneus, and their surfaces are more richly fissured.

FISSURES OF THE TEMPORAL LOBE

LATERO-VENTRAL SURFACES. — The supertemporal is broken up into three segments by isthmuses which join the super- and meditemporal gyres just ventrad of the pre- and medi-sylvian regions. The caudal piece is the longer (11 mm.), and anastomoses with a ramus of the parietal and with the meditemporal in the temporo-parietal transition. The middle supertemporal segment is zygal, and the cephalic one is a shallow triradiate fissure. The meditemporal consists of a segment in the cephalic region of the lobe, 6 cm. in length, and of another segment confluent with the subtemporal near the occipito-temporal transition. Further dorsad this piece also joins the supertemporal. The subtemporal pursues a tortuous course, attains a length of 9 cm., and anastomoses caudally with the meditemporal as described above. The collateral begins well cephalad, bifurcates caudad, and attains a length of 11.5 cm. The lateral limb ends in a zygal piece. The amygdaline (post-rhinal) fissure is indicated by a shallow groove.

GYRES OF THE TEMPORAL LOBE

The gyres of the temporal lobe exhibit a notable flexuosity and rich fissuration throughout. They are all massive and of bold contour, and the large number of fissural segments and ramifications give to the lobe an appearance of a superior degree of complexity.

THE INSULA

The left insula (island of Reil) shows a prominent preinsular pole. There are five preinsular gyres and one postinsular gyre, with eight peri-insular digitations in all. The fissures are deep, as insular fissures go (transinsular f., 6 mm.), and the general pattern is of a superior kind. The longitudinal (cephalo-caudal) diameter of the insula is 5.2 cm.

RIGHT HEMICEREBRUM

THE INTERLOBAR FISSURES

The Sylvian Fissure and its Rami. — The sylvian proper is unusually short, being 4.1 cm. between the points of origin of the presylvian and episylvian rami. Comparison with the left half

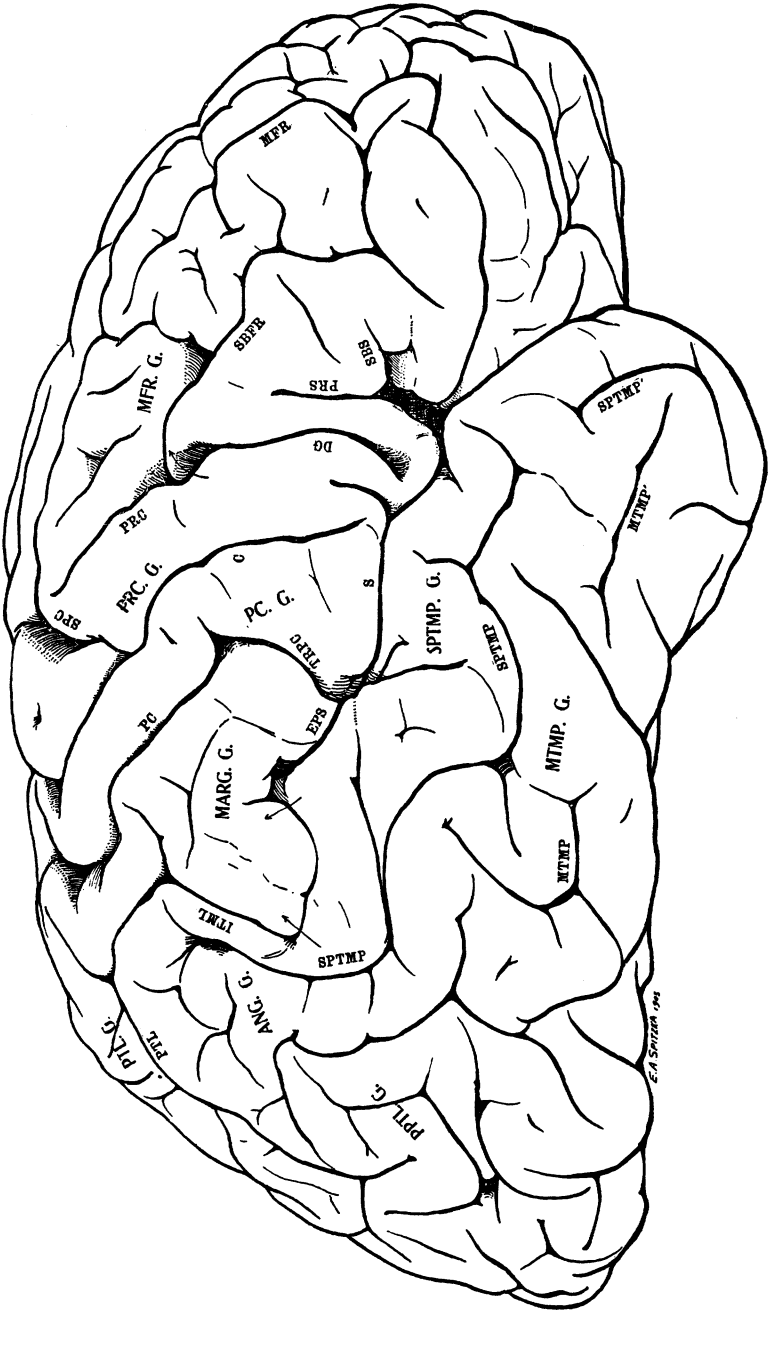

FIG. 46.—Lateral view of right hemicerebrum of J. W. Powell. (Natural size.)

shows this shortening to be due chiefly to the encroachment of the redundant subparietal regions, particularly the angular gyre. A similar redundancy, but more appreciable in the marginal gyre region, was found by Retzius in the brains of the mathematicians Gylden and Sonya Kovalewski, and the pedagogue and physicist Siljeström, also endowed with a superior mathematical faculty. In Powell's brain, the redundancy of the subparietal association area is most marked in the region adjacent to the visual centers; the marginal gyre is crowded cephalad rather than itself redundant.

The sylvian angle is 20°. The presylvian and subsylvian rami appear on the external aspect to spring from a common stem. On examining the depths of the sylvian cleft it is found, however, that these two rami spring from the circuminsular fissure independently of each other, and their superficial confluence is explained by the reduction of the preoperculum. The depths of the sylvian fissure are:

Presylvian point,	15 mm.
Medisylvian point,	23 "
Postsylvian point,	29 "

The episylvian is 2 cm. in length. Its walls are obliquely inclined, so that the temporal portion of the marginal gyre overlaps the parietal part in an opercular manner. Dorso-cephalad it is joined by the transpostcentral; caudad, by means of a shallow fissure, it anastomoses with the intermedial-parietal. The basisylvian is 23 mm. in depth.

The Central Fissure. — The central fissure is 11.3 cm. in length, but is not particularly flexuous. It anastomoses very superficially with the supercentral (vadum, 5 mm.). Its maximum depth (21 mm.) is near this anastomosis. Its dorsal end appears on the mesal surface for 2 cm.

The Occipital Fissure. — The occipital fissure is 2.5 cm. in length on the mesal surface, and the same on the dorsum. It is very deep (28 mm.) and in its depths exhibits a number of interdigitating subgyres. On the dorsum there is a deep fissural ramus giving an appearance of bifurcation.

The Calcarine Fissure. — The calcarine fissure is sinuously curved, simple, and unramified. Its length is 5.5 cm.

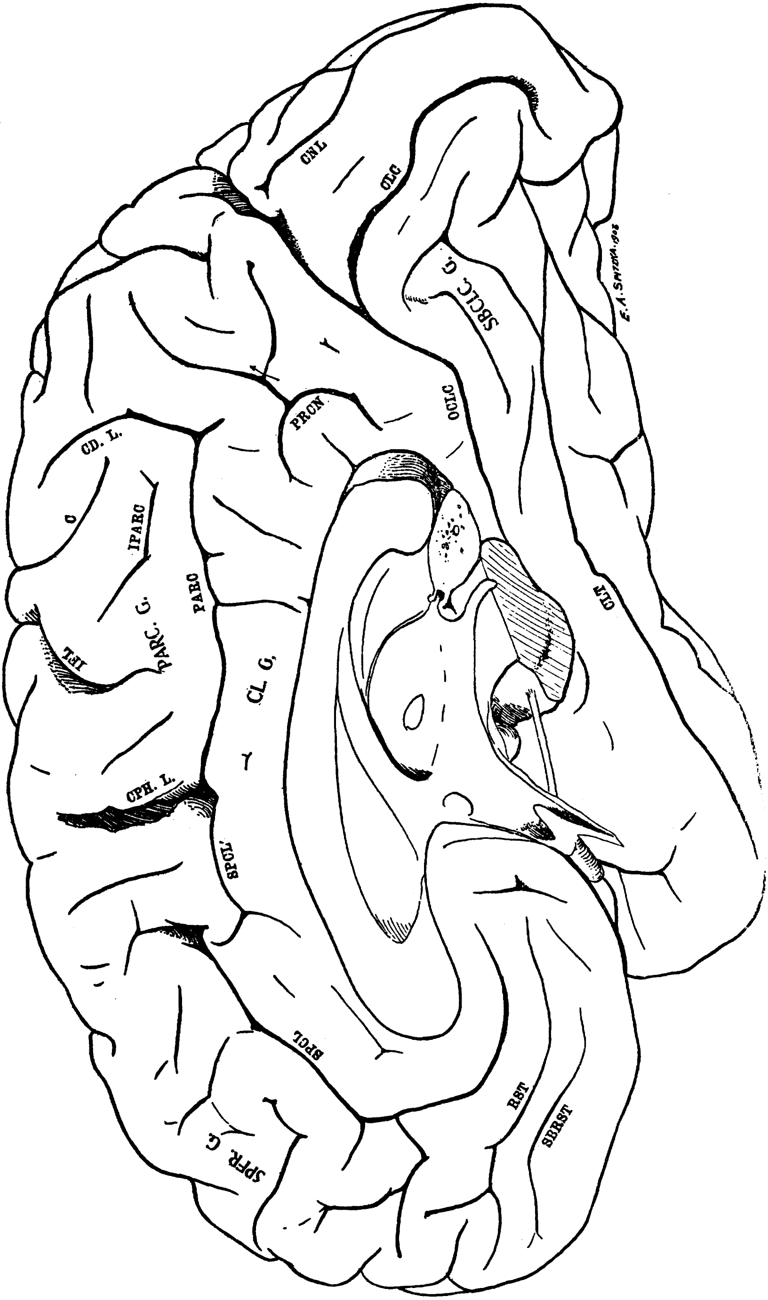

FIG. 47.—Mesal view of right hemicerebrum of J. W. Powell. (Natural size.)

The occipito-calcarine fissural stem is 4 cm. in length and closely approaches the hippocampal fissure.

FISSURES OF THE FRONTAL LOBE

LATERAL SURFACE. *The Precentral Fissural Complex.* — The supercentral is triradiate; apparently a zygal fissure with one limb suppressed, and in other respects resembling the corresponding fissure on the left side. The precentral is a straight segment, 4 cm. in length, deeply confluent with the subfrontal fissure and joined superficially (vadum, 9 mm.) by the diagonal. There is a short transprecentral.

The superfrontal passes cephalad from its origin in the supercentral for 6 cm., anastomosing across the medifrontal gyre with the subfrontal fissure. Two paramesial segments mark the superfrontal gyre. The medifrontal springs from the orbitofrontal and passes caudad in an irregular path for 6 cm. The orbitofrontal is 7 cm. in length. The radiate fissure, 3 cm. in length, is joined by the subfrontal fissure.

MESAL SURFACE. — The supercallosal fissure is again in two segments separated by an oblique superfrontal-callosal isthmus. The short caudal piece springs from the paracentral. The cephalic segment attains a length of 7.5 cm. The paracentral is long (4 cm.) and deep and has distinct cephalic and caudal limbs. There is a short longitudinal intraparacentral fissure. The inflected is a deep and well-marked fissure, traversing the dorsi-mesal margin and appearing for 2 cm. on both the mesal and dorsal aspects. The rostral and subrostral fissures are well marked.

ORBITAL SURFACE. — The orbital fissure is of zygal shape with its cephalo-mesal ramus (stipe) separated by a shallow vadum. The caudal rami, with the stem, form what is commonly described as the "transverse orbital fissure" of Weisbach. The olfactory fissure is 5 cm. in length.

GYRES OF THE FRONTAL LOBE

LATERAL SURFACE. — The precentral gyre, like the corresponding convolution on the left side, is broad and massive, and likewise partially interrupted by the supercentral ramus. The superfrontal

gyre is a trifle less wide, the medifrontal a trifle broader than on the left side. The subfrontal gyre is of the common type with small preoperculum.

MESAL SURFACE. — On the mesal aspect the superfrontal gyre is not so broad nor so richly fissured as on the left side, but in these respects is nevertheless superior to average brains of whites. The paracentral gyre is larger than the left.

ORBITAL SURFACE. — This region is not so squarely formed nor so broad as that of the left side, and the fissuration is of simpler degree. The tendency to the formation of a transorbital fissure demarcates a good-sized postorbital gyre with three sagittally directed preorbital gyres.

FISSURES OF THE PARIETAL AND OCCIPITIAL LOBES

LATERAL SURFACE. — As on the left side the postcentral segments anastomose quite deeply to form a long fissure which is bifurcated dorsally; ventrad it runs into the sylvian cleft by means of the transpostcentral, making its total length 9 cm. The parietal is independent of the postcentral and joins the intermedial cephalad, the paroccipital caudad. On the whole it lies further mesad than the corresponding fissure on the left side owing to redundancy of the subparietal parts, particularly of the angular gyre. The fissure shows numerous interdigitating subgyres in its depths. The paroccipital is of the typical zygal shape; its stem is 2.5 cm. in length. The exoccipital fissuration is exceedingly complex; the interpretation of the arrangement in this region is too difficult to yield satisfactory results in the present state of our knowledge.

MESAL SURFACE. — The precuneal fissure is of zygal shape, with its caudo-dorsal ramus partially separated off by a vadum. The cuneus is marked by a cuneal (or postcuneal ?) fissure.

GYRES OF THE PARIETAL AND OCCIPITAL LOBES

LATERAL SURFACE. — The postcentral gyre is well-formed but narrow, especially in its dorsal portion. The parietal is of smaller size than on the left; the paroccipital simple but of good size. It is in the subparietal parts that a notable differentiation and redundancy becomes apparent. The measurements in the appended

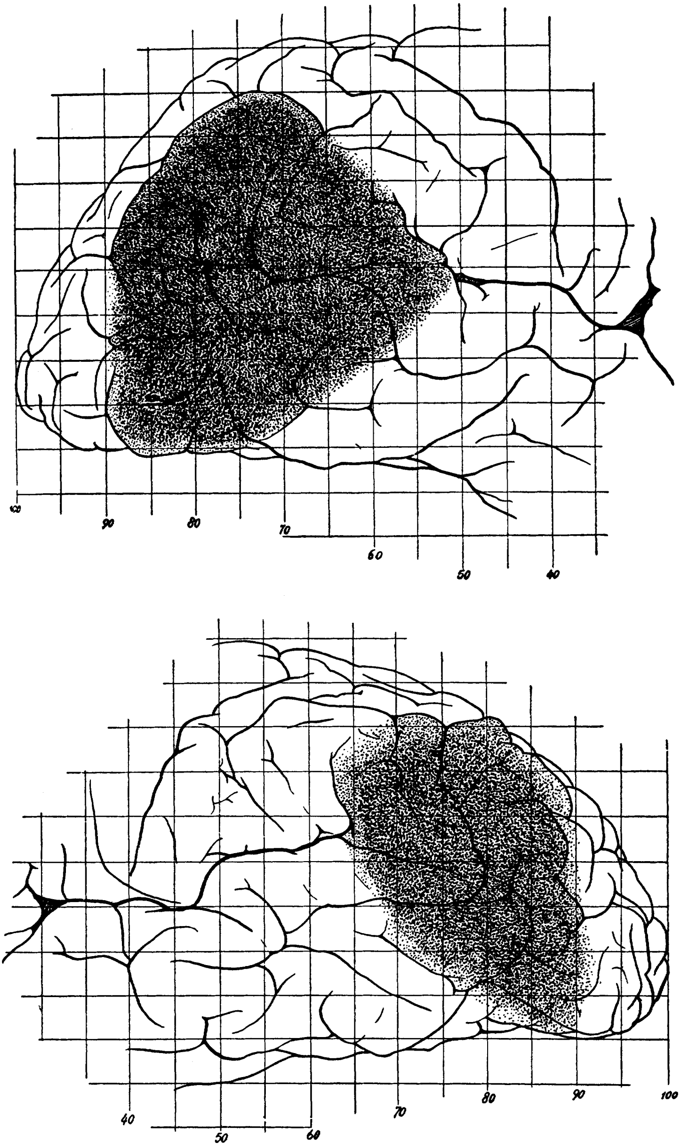

FIG. 48.—Views of right (upper figure) and left (lower figure) parieto-occipito-temporal regions; corresponding parts shaded. (The squares mark off areas in centesimals of the cerebral length.)

table show how the relative increase of this portion of the brain has encroached upon the sylvian fissure. Other special measurements corroborate these. The curve from the point of junction of the episylvian with the sylvian to the occipital pole is 11.2 cm. on the right, 10.0 cm. on the left. The curve from the same point to the dorsi-mesal margin across the parietal lobe is 9.2 cm. on the right, and 8.3 cm. on the left. The whole region is richly fissured, the angular gyre particularly so.

MESAL SURFACE. — Both the cuneus and the precuneus are much smaller on this side. The cuneus particularly is much reduced by the displacement dorsad of the calcarine fissure by the broad, redundant subcalcarine gyre. The surface-markings of these regions are quite simple.

FISSURES OF THE TEMPORAL LOBE

LATERO-VENTRAL SURFACE. — The supertemporal fissure is notable for its tortuous course and numerous ramifications. The larger segment attains a length of 12 cm.; the shorter segment lies cephalad and reaches to the temporal pole. The meditemporal fissure is represented by three separate segments. The subtemporal attains a length of 9 cm., and caudally bends sharply dorsad on the lateral surface, anastomosing with a meditemporal segment. The collateral pursues a straight course, 11 cm. in length, while the amygdaline is merely indicated by a shallow groove.

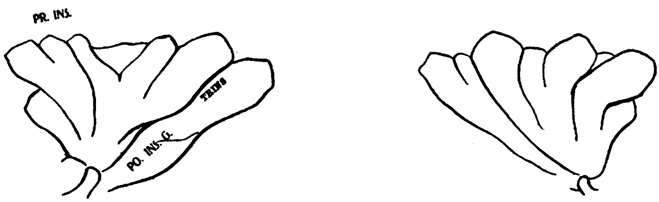

FIG. 49.—Left and right insulæ of brain of J. W. Powell. (× .63)

GYRES OF THE TEMPORAL LOBE

The supertemporal is rather more massive than that of the left half. In other respects the temporal gyres of the two halves resemble each other in the superior degree of development generally and in the flexuosity of the gyres and rich fissuration in particular.

THE INSULA

The insula resembles that of the left side in general pattern, but is of more rounded-off contour, for it does not exhibit the marked polar eminence nor yet quite the degree of differentiation from the common type as shown in the left insula. Its longitudinal diameter is 4.6 cm. (6 mm. less than that of the left).

PRINCIPAL MEASUREMENTS OF THE CEREBRUM (AFTER HARDENING)

	CENTIMETERS
Maximum length, left hemicerebrum,	17.4
Maximum length, right hemicerebrum,	17.4
Maximum width of cerebrum,	13.8
(Cerebral index, 79.3)	
Horizontal circumference,	50.3
Left semi-circumference,	25.2
Right semi-circumference,	25.1
Maximum width, left hemicerebrum,	7.1
Maximum width, right hemicerebrum,	6.7
Left occipito-temporal length,	13.6
Right occipito-temporal length,	13.0
Length of callosum,	7.4
(or 42.53 percent of the total hemicerebral length.)	
Left centro-temporal height,	10.1
(or 58.0 centesimals of cerebral length.)	
Right centro-temporal height,	10.4
(or 59.7 centesimals.)	
Left centro-olfactory height,	7.7
(or 44.2 centesimals.)	
Right centro-olfactory height,	8.0
(or 45.9 centesimals.)	

NOTE. — In estimating the last four measurements, it must be remembered that the left hemicerebrum was slightly flattened in the process of hardening.

ARC MEASURES ALONG DORSI-MESAL MARGIN (CUNNINGHAM'S METHOD)

Left Hemicerebrum

	CENTIMETERS
1. Cephalic point to central fissure,	15.5
2. Central fissure to occipital fissure,	5.0
3. Occipital fissure to occipital pole,	5.3

Right Hemicerebrum

		Centimeters
1.	Cephalic point to central fissure,	16.0
2.	Central fissure to occipital fissure,	5.0
3.	Occipital fissure to occipital pole,	5.0

CEREBRAL INDICES (BASED ON THE ARC MEASURES GIVEN ABOVE)

	Left	Right
Frontal index,	60.0	61.5
Parietal index,	19.4	19.2
Occipital index,	20.5	19.2

HORIZONTAL DISTANCES (EXPRESSED IN CENTESIMALS OF THE TOTAL HEMICEREBRAL LENGTH)

From the cephalic point to:

		Left	Right
1.	Tip of temporal lobe,	23.0	23.2
2.	Sylvian-presylvian junction,	31.0	30.4
3.	Ventral end of central fissure,	40.0	39.1
4.	Sylvian-episylvian junction,	63.7	51.7
5.	Caudal point,	100.0	100.0
6.	Cephalic edge of callosum,	20.1	20.1
7.	Porta (foramen of Monro),	40.2	40.2
8.	Dorsal end of central fissure,	61.2	64.4
9.	Dorsal intersection of paracentral fissure,	64.9	66.6
10.	Caudal edge of callosum,	63.2	63.2
11.	Occipito-calcarine junction,	57.3	75.8
12.	Dorsal intersection of occipital fissure,	86.7	86.7

CEREBELLUM, PONS, OBLONGATA

These parts are all in good proportion and show a good degree of development. The cerebellum is well formed and richly fissured. The pons is of good size and the medipeduncles are quite massive.

The principal measurements of the cerebellum are:

	Centimeters
Maximum height,	5.2
Maximum cephalo-caudal diameter:	
Left hemisphere,	6.0
Right hemisphere,	5.75
Dorsal length of vermis,	3.4
Maximum depth of caudal incisure,	1.1
Maximum lateral width,	10.1

The measurements of the pons are:

	Centimeters
Maximum length,	2.6
Maximum thickness,	2.75

Recapitulation

To recapitulate, the most notable features are:

(*a*) The weight of the brain, 1488 grams, which, for a man of small frame aged 68½ years is well above the average.

(*b*) A superior degree of fissural complexity and flexuosity of the gyres not affected by the atrophy accompanying old age.

(*c*) Superior degree of differentiation of the left subfrontal gyre (*i. e.*, emissary speech-center) as compared with that of the right.

(*d*) The left insula (*i. e.*, associative center for the speech faculty) exhibits a slightly superior differentiation; the preinsular pole is much more prominent than on the right, and the total size is somewhat greater.

(*e*) Great redundancy of the subparietal regions (*i. e.*, marginal, angular, and postparietal gyres on the right side, encroaching considerably upon the sylvian cleft.

(*f*) Preponderance of right frontal lobe (mesal surface) over the left, and a proportionate reduction of the right cuneus-precuneus as compared with the left.

(*g*) The precentral gyres are much wider and more massive than the postcentral.

(*h*) The supertemporal fissures are interrupted at about the same site on both sides.

(*i*) The epiphysis (pineal body) is unusually large.

IV

In the endeavor to correlate if possible the principal or most striking features of the cerebral anatomy with Major Powell's chief mental characteristics, the writer labored under the great disadvantage of never having had the opportunity of meeting the man during life. At Dr McGee's kind suggestion, the writer turned to some forty or more of Powell's acquaintances and friends (among them many eminent scholars) with the request that they give their estimate, briefly expressed, of his leading mental characteristics of mind

and action and of his relative place among the science-makers in this country or in the world. In wording the request care was taken to avoid suggesting anything that would prevent a fair, unbiased expression of opinion or which would draw forth merely eulogistic phrases. The writer desired above all else to ascertain in what way Major Powell's mental action was most notable. The results of this canvass were most gratifying and satisfactory. Replies were received from nearly every one addressed; they were all clear and to the point, and the writer believes that he has been able to obtain from them a fairly good composite picture of the man's chief characteristics and mental make-up.

It is but just to mention here that the writer had described and commented upon the cerebral features in their possible relations to Major Powell's mental characteristics some time prior to the transmittal of the letters of inquiry. In addressing the Anthropological Society of Washington (May 12, 1903), the writer said, in substance, that *the great development of the parieto-occipito-temporal association area (particularly in the right or preponderatingly sensory half) probably corresponded to a superior ability to register and compare the impressions in the visual, auditory, and tactile spheres (which together form the concept sphere).* That Major Powell's intimate friends and associates corroborated, in general, these presumptions, was indeed gratifying; the more so as all men possess innumerable traits and characteristics difficult or impossible to localize upon the brain-surface. But here was a brain which exhibited an unmistakable redundancy and organic superiority of development in a region of known function; a fact, which, if rightly interpreted, ought to lead to the deduction that the intellectual faculties in question should be correspondingly developed.

Such argument is not mere guesswork or speculation. Let us recall for a moment the related doctrines that the olfactory organs are large in osmatic, small or absent in anosmatic animals; or that the pyramidal tract is well-developed in animals endowed with prehensile voluntary usage of the extremities, while it is wanting in animals like the elephant and the dolphin. If such natural peculiarities of bodily function and brain-structure go hand in hand, the psychic functions must do so likewise.

Here let us recall the very pertinent distinction between the brain of man and that of the anthropoids where the association (and therefore intellectual) areas are superiorly developed in the former as compared with the latter. Let us make a closer analysis of the matter in order to see in how far this holds true in the study of Powell's case. The writer thinks that he cannot do better than to reproduce selections from the replies received. It is deemed best, for the present at least, to omit the names of the authors of the passages here cited:

"As a thinker he seemed marked by unusual independence. He had a vast body of facts and experiences all his own and gained at first hand, and upon these he based his thinking." "The Major was of a decidedly reflective turn of mind; he observed well, sharply, and he knew well to use his facts as bases for good inductions." "While he was president of the Anthropological Society, a position he held for many years, he rarely failed to take part in the discussion of any communication brought before the society, and it was his special function in such discussion to point out the relation of the ideas of the communication to the broadest generalizations of the science." "His method of observation perhaps had special character in it, in that it was usually controlled by previous generalization and theoretic considerations, and thus made systematic. He did not mention or publish observations by themselves, but only in classified form, or as illustrative of theoretic ideas." "In natural phenomena he had remarkable powers of perception and observation, and great keenness in these directions." "His mind was not satisfied to hold either facts or generalizations without explanation, and his search for explanation extended to the broadest generalizations and most fundamental concepts; it was his habit to refer all minor problems to the broadest possible categories." "His mentality was most notable for its capacity to arrive at proper conclusions speedily without burdensome analysis of detail." "A man of broad and comprehensive mental grasp; he seemed to be trying to get at the deeper meanings of things." "He was unusually gifted, and though coming from the plough showed a natural aptitude for philosophizing, viz., seeing everything in its connection with the whole." "His

best faculty was that of generalizing in terms of his own observations or experiences, *i. e.*, beginning with his own observations as interpretative nuclei he arranged and assembled facts, gathered by others as well as himself, in systems at once definite and comprehensive." . . . . "This was not only his leading faculty, but one in which he excelled all others. While by no means strong in mathematics, he had excellent command of the field of thought commonly considered abstract, as shown in his constructive discussions of logic ; yet even here he was led, by faculty as well as by deliberate purpose, to pursue interpretative methods, or the methods of natural science rather than metaphysical methods — so that here too, the ruling faculty was dominant. Not technically trained in music, he was in quite exceptional degree susceptible to music, as well as the drama, poetry, and painting ; and his scientific analysis of music and other fine arts was at once acute and masterly — the quality of the analysis partaking of the natural history method, and again expressing his power of generalizing under the guidance of his own sense impressions." "His clear view of the relations of concrete things made him a really good administrator and organizer of institutions ; like Bache for the Coast Survey and Baird for the National Museum or Fish Commission." "He certainly was a man of suggestion, thus bringing workers to him over whom he exerted a marked influence. He was a man qualified to rule and direct." "He was on the whole a good judge of character and was remarkably successful in getting the best out of every one with whom he had relations." "He always gave evidence of unusual breadth of mental vision. He had a broad way of looking at things. He had also rather unusual felicity of expression ; although he did not speak rapidly, his ideas were always clothed in very appropriate and expressive language." "There are few men to whom the scholarship of this country owes more ; but I believe it to be a debt less for his personal contributions to ethnology than for what he enabled, and one may fairly say compelled, other men to do." "He enjoyed 'blazing a trail' in science, but the trail made and open, he usually left to others the task of permanent road-building. Thus his work in geology brought into sharp distinctiveness certain features of geologic mechanics in

erosion, etc., which are at the root of the branch of geology called geomorphology, which has of late formed a school. The facts have long been known, but their relations had never been appreciated until he turned the searchlight on them. His great gift of sympathy brought him near the Indian, and he was almost the first to appreciate Indian philosophy of life and to be able to put himself at the Indian point of view, sympathetically." "Major Powell's salient characteristics were courage, sympathy, insight into relations of things."

"My feeling is that his greatness was rather in his personality; his honesty, his continuity, his invincible determination (joined with a very reasonable amount of tact for such a character) which chanced to be applied to this scientific field." "Whenever he decided upon any course of action, he carried it out with extreme force and energy, and without much regard to consequences." "I should think that unflinching courage was Powell's leading characteristic, whether it were to descend into the Grand Cañon, or to say something which he might have thought unpopular; his devotion to the truth distinguishing him from most other public men." "I know of no one who has so successfully, so wisely and so permanently organized the forces of national scholarship in a specific field as Major Powell."

"He had rare power of mental concentration, being able to restrict his attention to a selected subject for long periods. If interrupted (and he suffered himself to be interrupted freely) he would revert instantly to his subject of thought, and appeared to resume it without effort at the point of interruption. When fatigued he was able to refresh himself at almost any hour." "He was valiant, swift in action, keen in discerning." "I think fearlessness — intellectual and physical — was the trait which I most admired in him. He was serious, and endowed with good generalizing powers. His use of words was very definite and forceful — never subtle or of fine flower. A fine, strong, rugged, just, sincere man — that is the impression he made on me when I first met him." "He wrote much in verse, very little of which has been printed. His tendency was strongly imaginative, notwithstanding that he was addicted to scientific pursuits during so many years."

It is clear to any one who reads these passages attentively that the power which chiefly characterized Powell's intellectual ability was that of seeing analogies and making comparisons, of coupling observations and thoughts which to most people seemed not at all related to each other until by him placed in a certain light. With him the conception of the concrete outweighed thought in the purely abstract (the function, chiefly, of the frontal association areas). The rather superior, though not extraordinary, development of the area in closest proximity to the auditory field can safely be correlated with his good appreciation of music, not only of European composition but of Indians as well, as shown in his masterly analyses of Indian songs and melodies. As Dr McGee has stated, Major Powell was a 'potential musician' if not a trained one, and this statement is supported collaterally by the fact that his daughter and other blood-relations are highly accomplished musicians.

Keenness of observation, therefore, with a superior ability of forming concrete concepts, profound insight into the inter-relations of what he saw or heard, great capacity for associating and generalizing his thoughts and giving them expression in words; all these, with the musical and poetical faculties characterized Major Powell's mind. And since these mental qualities, taken collectively, are known to reside, without doubt, in this great "posterior association area" of Flechsig, which we have seen so extraordinarily developed in this brain (particularly upon the right side), we may feel justified in saying that here we have found a somatic expression of mental ability of a pronounced kind in the anatomical appearances of a distinguished man's brain.

Major Powell, geologist, ethnologist, explorer, philosopher, and soldier, was endowed with a superior brain, and, what is more, he used it well.

In conclusion I wish to express my hearty thanks to Dr W J McGee, to Dr D. S. Lamb, and to the many friends of Major Powell who have assisted me in this study.

ABBREVIATIONS USED IN THE ILLUSTRATIONS

FISSURES

ADOC	Adoccipital	*BS*	Basisylvian
AMYG	Amygdaline (post-rhinal)	*C*	Central
		CL	Callosal

CLC	Calcarine	*PC*	Postcentral
CLT	Collateral	*PCLC*	Postcalcarine
CNL	Cuneal	*PML*	Paramesal
DG	Diagonal	*POCN*	Postcuneal
EOP	Exoccipital	*PRC*	Precentral
EPS	Episylvian	*PRCN*	Precuneal
FMG	Frontomarginal	*PRS*	Presylvian
HMP	Hippocampal	*PTL*	Parietal
HPS	Hyposylvian	*RDT*	Radiate
IFL	Inflected	*RST*	Rostral
IPARC	Intraparacentral	*S*	Sylvian
IPRCN	Intraprecuneal	*SBC*	Subcentral
ITML	Intermedial	*SBFR*	Subfrontal
MCL	Medicallosal	*SBRST*	Subrostral
MFR	Medifrontal	*SBS*	Subsylvian
MTMP	Meditemporal	*SBTMP*	Subtemporal
OC	Occipital	*SPC*	Supercentral
OCLC	Occipito-calcarine stem	*SPCL*	Supercallosal
OLF	Olfactory	*SPFR*	Superfrontal
ORB	Orbital	*SPTMP*	Supertemporal
ORBFR	Orbitofrontal	*TRORB*	Transorbital
PARC	Paracentral	*TPRC*	Transprecentral
(*CPH.L.*	Cephalic limb)	*TRPC*	Transpostcentral
(*CD.L.*	Caudal limb)	*TRPTL*	Transparietal
PAROC	Paroccipital		

GYRES

ANG. G.	Angular G.	*PC. G.*	Postcentral G.
CL. G.	Callosal G.	*PO. ORB. G.*	Postorbital G.
HMP. G.	Hippocampal G.	*PRC. G.*	Precentral G.
INS.	Insula	*PR. ORB. G.*	Preorbital G.
PR. INS. G.	Preinsular gyres	*PTL. G.*	Parietal G.
PO. INS. G.	Postinsular gyres	*PPTL. G.*	Postparietal G.
MARG. G.	Marginal G.	*SBCLC. G.*	Subcalcarine G.
MFR. G.	Medifrontal G.	*SBCLT. G.*	Subcollateral G.
MORB. G.	Mesorbital G.	*SBFR. G.*	Subfrontal G.
MTMP. G.	Meditemporal G.	*SBTMP. C.*	Subtemporal G.
PARC. G.	Paracentral G.	*SPFR. G.*	Superfrontal G.
PAROC. G.	Paroccipital G.	*SPTMP. G.*	Supertemporal G.